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**Economics of Crime and Punishment
with Reference to the Scottish
Criminal Justice System**

by

Mark Charles Graham

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ABSTRACT

The thesis initially aims to expand on the prescriptive social loss model by incorporating differing views about the role of punishment and the effects thereof upon the original model. Utilitarian, retributive, rehabilitative, and expressive roles and their potential combinations are examined. Their incorporation into the original model leads to a series of opposing 'optimum' positions. It is concluded that no generally acceptable optimum position may be derived. Despite this indeterminacy a common basis of all the prescriptive models is deterrence. So the thesis proceeds to comprehensively measure for the existence of a deterrent effect. A descriptive macro-crime supply model for Scotland is developed for regional annual property crime rates (Class Two and Three) over the period 1970-1978. The basis of the model is embodied in three relationships: the crime rate, certainty and expenditure functions. This model is tested and results analysed using a time series cross section simultaneous log-linear equation framework. Additionally relationships accounting for: recording effects, differences in perceptions, and severity effects are incorporated. Finally the effect of both structural change (1973 Local Government Act) and inter-regional differences (eight regional forces) are analysed.

I Certify that this Thesis is my own composition

Mark C Graham

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CHAPTER 1

THE ECONOMICS OF CRIME AND PUNISHMENT

1.1. Introduction

In economic theory individuals are assumed to make choices according to the consequences they perceive. Deterrence may be defined as the choice not to commit a criminal act in response to a perceived risk of punishment: "man may be controlled by his fear of punishment".¹ This thesis analyses the implications for society of this assumed response to punishment.

Initial theoretical assumptions (necessarily) constrain the questions economists attempt to answer. However they sometimes (unnecessarily) constrain their answers. The economic theory of crime and its punishment poses two major questions:

1. how do potential offenders respond to changes in expected punishment levels: and,
2. given their response, what punishment levels are the most efficient?

Initially assuming punishment is a price, the law a price list, economic theory prevents the economist from stating that punishment is NOT a deterrent. Consequently the answer to (b) is obvious: the most efficient level of punishment is that which deters the most offences at the least social cost. The present study contends that even if punishment is a deterrent, this second answer is not necessarily correct. Reformulating the second question as:

- (i) how does one know if existing criminal justice practices are inefficient?;

one cannot answer this question by 'knowing' the answer to (a). Only knowledge of the purpose of existing practices allows one to determine if they are inefficiently achieved. The first and primary aim of the present study is to outline the possible roles that punishment (means) are believed to fulfil (ends).

Utilitarian, retributive, rehabilitative and expressive roles, and their potential combinations, are examined. On assumption of at least partial acceptance of the economic approach in determining criminal justice policy (i.e. minimizing social loss) the effects of incorporating these views into the basic social loss model are illustrated. However it is found that the question of whether practices are optimal (c)' is indeterminate; if punishment serves other goals than deterrence the potential conflict among these goals cannot be resolved on utilitarian grounds. What may potentially be resolved is acceptance of the economic approach itself since this fundamentally depends upon potential offenders' assumed response to punishment, i.e. that punishment deters.

The second aim of the present study is therefore addressed at (a). An econometric model is developed of the Scottish Criminal Justice System for aggregate property crime rates over the period of 1970 to 1978. The basis of the model is embodied in three relationships: the crime rate function, the certainty function, and the expenditure function. Additionally relationships accounting for (any) recording effects, differences in perceptions and severity effects are also incorporated. Finally the effects of both structural change (1973 Local Government Act) and inter-regional differences (eight regional

forces) are also analysed. The model is estimated and results reported using a simultaneous log-linear equation framework. While there is limited evidence of deterrence, the results obtained do not provide a sufficient platform upon which to draw conclusions about the relevance of the economic model to actual Scottish Criminal Justice System practices.

The purpose of Chapter One is to provide an introduction and analysis of BECKER's original 'prescriptive social loss model', ("Crime and Punishment: An Economic Approach", Journal of Political Economy 1968) and a survey of the resultant literature, analysing both criticisms of Becker's model and the implications derived.

Emphasis throughout is placed on the social loss model for two reasons. Firstly models of the decision to commit an offence have been fully developed elsewhere. They show that if the time allocated to legal and illegal activity is introduced explicitly into utility functions no comparative static results are forthcoming under traditional preference restrictions, and furthermore, no conclusions may be drawn concerning behaviour toward risk. This restricts the possible interpretations to be placed on any theoretically postulated deterrent effects (vis a vis risk) while emphasizing the need to determine empirically if such effects exist at all.

Secondly, as indicated in the conclusion to this chapter, Becker's original social loss model has not been fully developed to take account of different views of the Criminal Justice System's purpose. While the incorporation of such views is developed in Chapter Two, concentration is placed on the original model in this chapter in order to provide a basis from which to

include these incorporations, while also indicating that in the social loss model, the 'optimum level of punishment' does not depend nor (necessarily) imply anything about preferences for risk.

1.2. Assumptions

Economics is concerned with the optimum use of scarce resources. In the field of crime and punishment therefore economics deals with the normative question: 'how many of society's scarce resources should be devoted to crime prevention?' The first attempt to answer this question was formulated by Becker who stated that the optimum solution is that which minimizes the social loss from crime in order that society has the maximum resources left to use for other purposes. Since Becker's model provides, if not the basis, at least a catalyst for all recent studies it is of central importance that the assumptions and implications of this model are understood. In outlining the model due weight is given to the criticism of others.

Analysing potential changes in policy requires the stability of some frame of reference. Becker assumes that the definition of 'crime' is given. This assumption bypasses two problems. Firstly defining crime in terms of specific actions since the definition of crime differs over societies: "a property owning society will define deviance with respect to its property owning concepts... a nomadic society will regard deviance from its norms as actionable a religious society will define deviance beyond certain limits as heresy", (L.T. WILKINS. 1964). Secondly, evaluating the political process whereby certain behaviour is judged to be criminal. There are two reasons for this. The determination of society's values lies outwith economic theory. "it requires a political theory rather than an individualistic ethical theory to account for

policies and goals whose chief commendation to a substantial minority of people is that their acceptance spares them a term in "jail". (G.J. STIGLER, 1965). Furthermore, economists necessarily wish to stress the need to analyse efficient resource use given society's values for: "an operational system for criminal justice cannot be evaluated in categorical terms of ethics or jurisprudence alone. To do so would eliminate for consideration the constraints placed on society by the limits of technology and resource availability and the fundamental choices which these limitations require" (R.C. LIND and J.P.J. LIPSKEY, 1971)

Given that the definition of crime is known, in order to minimise social loss the concept of 'social loss' itself has to be defined. This Becker does by specifying a social loss function. The first component of Becker's social loss function is the net damages from offences:

$$D(O) = H(O) - G(O) \quad (1)$$

$D(O)$ is the level of damages that result from offences O and is obtained by subtracting the gain to offenders $G(O)$ from the harm done to others $H(O)$. Further:

$$G' > 0 \quad G'' < 0 \quad \text{and} \quad H' > 0 \quad H'' > 0 \quad (1a)$$

as offences increase so do gains and harm, gains at a diminishing rate and harm at an increasing rate. Crime being an 'externality' the offender obtains

diminishing marginal utility from his actions, the victim, increasing marginal costs. Becker restricts his analysis to the region where net damages are positive (i.e. $D > O$), arguing that where $D' < O$ an extra offence is 'beneficial' (i.e. involves no social loss) because the gains to the offender outweigh the losses to the rest of society. This view has led others to criticise the punishment of 'victimless crimes'. These crimes are: "victimless in the sense that the persons punished as criminals do not consider themselves as victims since they willingly seek illegal transactions" (D. GLASER, 1973), in the absence of legal prohibition such transactions could be regarded as ordinary exchange trade. For if these activities cause no damage (i.e. $D' (O) < O$) by considering them as 'crimes' society is wasting scarce resources on their control.²

By redefining these activities as legitimate such resources could be used to achieve other 'more desirable' ends. However even if the social cost of victimless crimes is to consider them crimes others argue that for theft (and presumably other offences) there is no offence level where $D' (O) < O$. "The community should treat losses sustained by victims as a net cost, without offset for the benefits obtained by the thieves" (R.L. CARTER, 1974); society should assign a zero welfare significance to offender's gains. For even if in utility terms no apparent net social loss results (i.e. $D' (O) < O$), the transaction is still a 'contested transfer' (G. TULLOCK, 1971). Social costs arise because both parties use resources to contest the transfer: both have an incentive to prevent the success of the other. Net damages should therefore be regarded as the subjective value of harm only.

The second component of Becker's social loss function is the 'cost of apprehension and conviction':

$$C = f(O, p)$$

(2)

public expenditure on the Criminal Justice System (C.J.S.) is a function of the probability of conviction p and the level of offences O . Further

$$C_p > 0 \quad C_{pp} > 0$$

(2a)

given offences, costs increase as the probability of conviction increases as does marginal cost: apprehension risk is positively related to police resources where these resources display decreasing marginal productivity. Additionally,

$$C_o > 0 \quad C_{oo} > 0$$

(2b)

given the probability of conviction, costs increase as offences increase as does marginal cost: with decreasing marginal productivity the cost of maintaining a given level of p increases (at an increasing rate) as offences increase.

The final component of Becker's social loss function is the 'social cost of punishment':

$$bfpo$$

(3)

where b is the co-efficient that transforms punishment per offence into the social loss per offence punished, and p . O is the total number of offences punished. The size of b varies between punishments. $b = O$ for fines, since fines produce a gain to 'others' that should equal the costs to an offender, aside from collection costs i.e. fines are 'transfer payments'. Whereas $b > O$ for imprisonment: imprisonment adds to social loss by absorbing scarce resources through incarceration of offenders.

The total loss from crime L is identical to the total social loss from offences, convictions and punishments:

$$L = D(O) + C(O,p) + bfp_o \quad (4)$$

; society's objective should be to minimize the social loss function. As f and p are the decision variables subject to social control (b is regarded as a given constant greater than zero) their optimum values are found by differentiating L with respect to p and f . However since C.J.S. activity is not determined by, but is also a determining factor of the level of crime, predictions about the response of criminals to changes in p and f are also necessary before the 'optimum' can be illustrated.

Becker outlines the following supply function:

$$O = f(p, f, u) \quad (5)$$

in any given period, the number of offences committed O is a function of the probability of conviction p , the punishment if convicted f , and a portmanteau variable u representing all other influences. Further

$$O_p < 0 \quad O_f < 0$$

(5a)

an increase in the probability or severity of punishment reduces the number of offences. Becker derives this result by assuming that in any given period 'legal activity' and 'illegal activity' are mutually exclusive. The utility from legal activity is

$$U_L(Y_L)$$

(6a)

where Y_L is income, monetary plus psychic, from legal activity, and U_L is the utility function. The expected utility from committing an offence is:

$$(1 - p) U_i(Y_i) + p U_i(Y_i - f)$$

(6b)

where Y_i is income, monetary plus psychic, from an offence, and U_i is the utility function. In both cases it is assumed that the marginal utility of income is positive. A 'rational' person (i.e. utility maximizer) will compare the expected utility associated with each outcome and choose the option with the highest expected utility. He or she will commit an offence if:

$$U_L(Y_L) < (1 - p) U_i(Y_i) + p U_i(Y_i - f)$$

(6c)

however given that the expected utility from an offence decreases as p and f increase,³ the number of people (and therefore the number of offences) for which (6c) holds decreases as p and f increase. Thus the number of offences committed is a decreasing function of the probability of conviction and the severity of punishment – i.e. (5a). Expected punishment is a deterrent, by raising the expected costs of crime the frequency of future offences is reduced. Critics of this approach adopt several positions.

First it is argued that the assumption of rationality and utility maximization are unrealistic – potential criminals are not 'rational', adjustments to the expected benefits and costs of crime do not alter decisions to commit crime. For example: "... those who 'actually' work with offenders are aware of the impulsively nonrational nature of much crime, including crimes against property".⁴ Obviously the assumption of rationality is unrealistic if interpreted literally, however: "the economic approach does not assume that decision units are necessarily conscious of their efforts to maximize or can verbalize or otherwise describe in an informative way reasons for systematic patterns in behaviour" (G.S. BECKER, 1974); individuals are assumed to behave only 'as if' they were rational. The validity of these assumptions is therefore not to be judged by their realism but by their predictive power.⁵

Other critics direct attention to the relative importance attached to p and f in explaining criminal behaviour – other factors (u) may be central in determining crime levels. For example: "what particularly bothers me about Becker's

scheme ... is his inclusion of a catchall variable, a person's willingness to commit an illegal act in the first place without specifying the importance of this factor alone, and in comparison to the factors that he does enumerate, and without discussing the important factors that influence one's willingness to commit illegal acts" (W.C. Bailey, 1973). However given that assumptions are necessarily unrealistic, tastes have to be either assumed constant or stably distributed. Subjective factors (u) have to be separated from the 'objective' opportunities people confront. Justification is two fold. First, assumed separation allows determination of whether crime is affected by changes in opportunities. Second, in economic models concern is directed towards the short-run practical problem of efficient resource use within a given C.J.S. framework. If deterrence 'works' predictions are correct and resources may be allocated (more) efficiently. By definition no explanation of why deterrence works is necessary. Whether this approach is best is debateable.⁶ But given no tendency to interpret observations of deterrence 'as' rather than 'as if' a result of rational behaviour, conflict between alternative views of criminal behaviour need not arise. Analogy (rational criminals) and explanation (criminal preferences) are separate.⁷ Both however should add to understanding the C.J.S.⁸

Other critics question Becker's specification of criminal choice. EHRLICH (1973) argues that legal and illegal activities are not necessarily mutually exclusive. Postulating an expected utility function:

$$EU = p U(X_a) + (1 - p) U(X_b)$$

(7)

where:

p = probability of conviction

$U(X_a)$ = utility derived if caught and punished

$U(X_b)$ = utility derived if offender not caught

; EHRLICH shows that crimes will only be committed when the marginal reward from crime is greater than the expected value of punishment.⁹ Reactions to changes in variables are unclear; simply stated only increases in p unequivocally reduce the likelihood of crimes being committed.¹⁰ Others using alternative formulations, for example W.M. BROWN and M.O. REYNOLDS, arrive at similar conclusions. However, before reviewing the impact of these conclusions upon the 'optimum' level of expected punishment, the optimum position has first to be analysed.

Using Becker's framework the first order conditions for an 'optimum' are:

$$\frac{\partial L}{\partial f} = D' O_f + C' O_f + bpO + bpfO_f = 0$$

(8)

$$\frac{\partial L}{\partial p} = D' O_p + C' O_p + C_p + bfO + bpfO_p = 0$$

(9)

which given (5a) and defining the elasticity of demand for offences with respect to f and p as ϵ_f and ϵ_p may be reformulated¹¹ as:

$$D' + C' = -bpf \left(1 - \frac{1}{\epsilon_f}\right)$$

(8a)

and

$$D' + C' + Cp_{Op}^1 = -bpf \left(1 - \frac{1}{\epsilon_p}\right)$$

(9a)

Thus first order conditions require that p and f should be set at that offence rate where the marginal cost of a change in criminal activity; the left hand sides of (8a) and (9a) – equal the marginal cost of enforcement – the right hand sides of (8a) and (9a).¹²

On the basis of this analysis BECKER concluded that a necessary condition for social cost minimization is that:¹³

$$1 > \epsilon_p > \epsilon_f > 0$$

(10)

; at the optimum the 'deterrent effect' of a percentage increase in the marginal penalty per offence falls short of an equal increase in the probability of apprehension. This implies, from (6b), that at the optimum all offenders must be risk preferrers. For if the percentage change in expected utility from an increase in p is greater than the percentage change in expected utility from an equal increase in f then¹⁴

$$U_i(Y_i) - U_i(Y_i - f) > f U_i'(Y_i - f)$$

(11)

; ie where the utility function is convex¹⁵, which corresponds to increasing marginal utility of income, and hence 'risk preference'. It is this implication which, as previously noted above, some have criticised.¹⁶

If potential criminals are assumed to obtain potential gains from crime. Recasting (6b) as:

$$(1 - p) U_i(Y_p + G) - p U_i(Y_p - f)$$

(6d)

where

Y_p = present 'certain' income

G = prospective gains from crime

then condition (11) becomes:

$$U_i(Y_p + G) - U_i(Y_p - f) > f' U_i'(Y_p - f) \quad (11a)$$

Now unless (11a) holds for all values of G , the inequality may be reversed.¹⁷ Hence: "risk avoidance implies nothing about differing responsiveness to probability of conviction vis a vis punishment", W.M. BROWN and M.O. REYNOLDS (1973)

Clearly, given the efficiency conditions for the C.J.S. and determining the response of individuals to these conditions is indeterminate limits the analytical value of Becker's original model, while also underlining the necessity of empirically testing for any assumed deterrent effect. However focusing on individual choice necessarily ignores the choice of the C.J.S. itself. For by assuming a choice of which C.J.S. to adopt, and then determining how such choices may be efficiently pursued within Becker's initial theoretical framework, allows various comparative analytical implications to be drawn. Before developing this approach (see Chapter Two) and to provide a contrast to the resultant predictions, the other implications which may be derived from Becker's initial framework using standard micro-economic principles are outlined below.

1.3. Implications

Minimizing the total social loss from crime does not imply the elimination of all offences. To spend more on crime prevention after 'the optimum' is obtained would be to waste resources capable of yielding more benefit in

alternative uses: "expenditure on prevention and enforcement should yield a diminution in offences at the margin equal to the return upon these resources in other areas" G.J. STIGLER (1970) This (opportunity) cost limitation upon enforcement prevents society from detecting and punishing all offenders. However, if punishment is a deterrent (i.e. $O_f < 0$) then there may be no offsetting costs to increasing f . For although where $b > 0$, the social cost of punishment (bf) rises as f rises, where $b = 0$, simple cost minimization dictates¹⁸ that p should fall to zero and f should rise to infinity "if deterrence is costless through f we should avoid using the costly p " N. STERN (1978). This conclusion is unrealistic – what is an infinite fine? However to show it as logically incorrect critics adopt several arguments

First, raising all fines would blur the distinction between 'serious' and 'less serious' crimes so encouraging criminals to upgrade their crime at little additional net cost. If a thief is fined £10,000 for stealing £5, he or she might as well steal £5,000 i.e. "marginal costs are necessary to marginal deterrence" G.J. STIGLER (1970). Second, as HARRIS (1970) shows, raising a fine also raises the social cost of an 'erroneous conviction' (R). If the marginal benefit from increasing the value of a fine is subject to declining marginal returns (i.e. $O_f < 0$ and $O_{ff} > 0$) and the offsetting cost (which is not included in Becker's model) is subject to increasing marginal weight (i.e. $R_f > 0$ and $R_{ff} > 0$) then the 'optimal' fine will not be infinite. For as a fine increases the marginal cost of punishing the innocent would at some value of this fine outweigh the marginal benefits (through reduced offences) derived.¹⁹

Another argument against infinite fines is that as fines increase so does the fines valuation of a marginal unit of income. At some point the marginal unit

of income to a finee could be more valuable than the unit to the government, and total social welfare would 'decrease' i.e., $b > 0$. Alternatively if account is taken of gains, then if offences involve transfers from relatively rich victims to relatively poor offenders $D' < 0$ and no punishment 'should' be imposed.

Finally a fine does not represent total perceived punishment. If the "social consequences of conviction"²⁰ (e.g. changes in family and social relationships and employment opportunities) are taken into account fines 'should' not be infinite – the offsetting increase in this cost would be some point outweigh the benefit (in terms of reduced costs) from increased fines (i.e. again $b > 0$). It must be noted though that 'logically' if fines were infinite the above arguments would not hold: there would be no convictions i.e. $p = 0$. However assuming realistically that fines will be set below infinitely further implications arise.

Assuming (8a) is an optimum condition, dividing through by O_f yields

$$L_f = D' + C' = 0 \quad (8b)$$

substituting (1) for D' then:

$$G' = H' + C' \quad (12)$$

iff $p = 1$, offenders will undertake offences until at the margin expected benefits (G') equal expected costs ($p.f = f$) hence:

$$f = H' + C'$$

(12a)

the optimum fine equals the total (marginal) social costs of the offence (i.e., $p = mc$). Obviously where $p < 1$, f would be higher by a value of $1/p$. In all cases though the level of f is independent of a convicted offenders income. For given $b = 0$ it must be (implicitly) assumed that at the margin the transfer involved (f) from finee to the C.J.S. does not change social welfare. But to return to an earlier argument this assumption may not be valid. For if transfer does cause a rise or fall in social welfare $b < 0$ or $b > 0$ respectively. Inclusion of these distributive effects has the following implications. If $b < 0$ for an optimum to exist either $\epsilon f > 1$ or $D' < 0$. Fine levels may be limited in increase either by a reduction in revenue outweighing the reduction in damages and costs, or by offence levels being 'beneficial'.²¹

Where $b > 0$ initial optimum conditions hold. However, in this case expected marginal gains for 'poor' offenders may be positive (i.e. $G' > pf$) encouraging transfers from rich to poor. Although not in itself a 'bad thing' such transfers could be undertaken in a less socially disruptive and certainly more efficient manner (i.e. without $D(0)$ and $C(0,p)$ through direct government intervention). Equity therefore conflicts with efficiency. Varying fines may be equitable but not efficient, not varying them may be efficient but unequitable.

In contrast to the above it may be efficient for fines to vary when stolen goods are recovered. Their value could be deducted from a fine in recognition of the fall in social loss (via a fall in $H(0)$) and as an incentive for the finee to return the goods. This would not effect expected punishment since the fall in the fine would be offset by the fall in criminal gains. If total perceived

punishment in monetary terms (f_a) equals all the losses (L) and gains (G) from an offence then:

$$f_a = - (L + G)$$

(13)

if G falls ($G > 0$) an offsetting fall in L ($L > 0$) leaves f_a unchanged, and given p , pf_a also. Hence offences would not increase. However without this offsetting fall convicted criminals would have no incentive to disclose stolen goods (i.e. lower G) because their punishment ($-(L+G)$) would increase i.e. no 'rational' offender will voluntarily increase his or her punishment.

The same type of argument may be used to justify 'plea bargaining'. If an apprehended criminal confesses he is certain to be punished. If he does not confess he has a finite chance of being found innocent. If the level of punishment (f) is the same whether he confesses or not, confession is not rational:

$$f > p_2 f$$

(14)

where P_2 represents the probability of conviction conditional on arrest. However if certain punishment (f) is lower than probable punishment (f) then some individuals will prefer the certain outcome (f) to the uncertain outcome ($p_2 f$) and confess.²² As long as certain punishment remains above or equal to uncertain punishment (i.e. $f > p_2 f$) then society will benefit. The costs of conviction are reduced without any offsetting losses via increased offences: expected punishment remains unchanged.

Another implication derivable from Becker's original model concerns the 'cross

elasticities of demand' for various punishments. Increasing the expected punishment for one offence may induce a substitution into, or a complementary move out of other offences. Assuming that

O_a = Offence type (a)

O_c = Complementary offences for (a)

O_s = Substitute offences for (a)

where:

$$\begin{aligned} O_a &= f(f_a, f_c, f_s \dots) & \partial O_a / \partial f_a, \partial O_a / \partial f_c &< 0 \\ & & \partial O_a / \partial f_s &> 0 \end{aligned} \quad (15)$$

$$\begin{aligned} O_c &= f(f_a, f_c, f_s \dots) & \partial O_c / \partial f_a, \partial O_c / \partial f_c &< 0 \\ & & \partial O_c / \partial f_s &> 0 \end{aligned} \quad (16)$$

$$\begin{aligned} O_s &= f(f_a, f_c, f_s \dots) & \partial O_s / \partial f_a, \partial O_s / \partial f_c &> 0 \\ & & \partial O_s / \partial f_s &> 0 \end{aligned} \quad (17)$$

the original social loss function (4) may be formulated:

$$L = D(O_a, O_c, O_s) + C(p_a, p_c, p_s, O_a, O_c, O_s) + b_1 p_a f_a O_a + b_2 p_c f_c O_c + b_3 p_s f_s O_s \quad (18)$$

If the complementary and substitution effects are ignored the first order differential for offence type (a) with respect to f_a only is:

$$Lf_{ao} = D'_a + C'_a + b_1 p_a f_a \cdot 1 - 1/\epsilon f_a \quad (19)$$

but given that:

$$C = (D_c + C_c + b_2 p_c f_c) \quad (20)$$

$$S = (D_s + C_s + b_3 p_s f_s) \quad (21)$$

and introducing complementary and substitution effects the social loss optimum for (a) with respect to f_a from (18) is:

$$Lf_{al} = Lf_{ao} + [C] \frac{\partial O_c}{\partial f_a} \cdot \frac{1}{O_{af}} + [S] \frac{\partial O_s}{\partial f_a} \cdot \frac{1}{O_{af}} = 0 \quad (22)$$

where:

$$[C] \frac{\partial O_c}{\partial f_a} \cdot \frac{1}{O_{af}} > 0 \quad (23)$$

$$[S] \frac{\partial O_s}{\partial f_a} \cdot \frac{1}{O_{af}} < 0 \quad (24)$$

so in comparison to the original optimum condition (i.e. $Lf_{a0} = 0$), the marginal cost of (a) is increased by (23) and reduced by (24). Condition (23) describes complementary effects for (a): reductions in f_a lead to increases in O_c as well as O_a . Condition (24) describes substitution effects: reductions in f_a lead to reductions in O_s (assuming that O_s (all substitute offences of O_a) has no complements). Taking both effects together the optimum level of f_a will be higher, equal, or lower relative to the original optimum as (23) (24).²³ Hence, considered separately reductions in the optimum level of f_a may appear inefficient (i.e. $Lf_{a0} > 0$). However if this reduction induces a move out of other substitute crimes the social losses from all crimes will be lowered (until $Lf_{a1} = 0$). For f_c predictions similar to f_a arise, for f_s the substitution effect predominates: O_s has no complements.²⁴ The difference between f_a , f_s , f_c will be determined by the relative weights attached to all losses. For example, if over all O_s and O_a total social losses for O_s are everywhere greater than O_a the optimal level of $f_s > f_a$. The same conclusions are derivable for p given that changes in any one probability do not directly affect another.²⁵

A final implication allied but not drawn from Becker's model concerns the 'industrial' structure of criminal output. If monopoly in the supply of 'goods' is inefficient (i.e. higher prices and lower output vis a vis competition) then it may be desirable for 'bads' because of this inefficiency. This is the first argument to monopolization of crime. It presumes there is no perfect discrimination and that there is some form of voluntary agreement between buyers and sellers (e.g. victimless crimes).²⁶ This last assumption does not hold in the case of predatory crimes ("predatory crimes are acts in which a person deliberately takes or injures someone else's person or property", D GLASER (1973)), because they involve contested transfers.

However a second argument for monopolisation covers both victimless and predatory crimes. If the resource inputs to the criminal industry are not available at constant supply price, a monopsonist unable to discriminate among owners of specialised inputs will, in order to maximize profits (i.e. $MC = MRP$) hire a total input below that generated under a competitive organisation. Thus total output produced will be below that of a competitive structure.

Finally a rational and monopolistic criminal organisation will look upon its 'victims' as long term sources of revenue. It has an incentive to husband 'victim resources' by placing a shadow price on their increase. On the other hand the competitive criminal organisation sees victims as a one time benefit source – a foregone victim may be captured by a competitor – it will not value the future of victim resources at all. Under a monopoly situation then there is likely to be a smaller 'input' of victims as compared to perfect competition. All the above suggest there are social benefits from the monopolisation of crime. A change from competitive to a monopoly structure would lower the level of offences and hence costs at which losses are minimized. Of course if a monopoly exists because of 'economies of scale' none of these arguments hold: output (i.e. offences) will be greater than under competition.

1.4. Conclusion

From the above it is clear that optimal levels of p and f depend on how initial assumptions are perceived. In particular the application of standard micro-economic principles to the original social loss framework yields various alternative predictions to those derived by Becker. Such applications are

limiting: however viewed the efficiency conditions that arise from these applications still imply that the objective of society in operating the C.J.S. should be to minimize social losses using expected punishment as a deterrent; deviations from this objective are by definition inefficient. Why should this be the case?

Inefficiency means that what society (theoretically) does is different from what it wants to and therefore should do. Provided there is consensus on the optimum conditions this is correct. In practice consensus is unlikely: "conceptually agreement may be attained, but practically the choice of a set of punishment institutions presents more difficulties in obtaining compromises among differing preferences than almost any aspect of the imagined constitutional contract", J.M. BUCHANAN (1975); punishment may be believed to fulfil other roles apart from deterrence. The determination of these beliefs lies outwith economic theory,²⁷ hence their non-inclusion in previous analyses of the social loss model. But unless the economic model of the C.J.S. is regarded as the 'ideal' solution then the resulting alternatives should, and can, be analysed without necessarily concluding that deviations from the economic view are inefficient. The social loss model may not, as BECKER pessimistically concluded, be hampered by: "the absence of a reliable theory of political decision making", G.S. BECKER (1968). For even though punishment may not be used as a deterrent it is still a matter of choice what role it should play: "the exogeneity of some gives may be a matter of the decision makers choice" L.A. Boland (1982). So without (explicitly) questioning why these choices are made the social loss model may be used to analyse and predict their outcomes.

Finally, before developing this (alternative) approach it must be noted that it is an implicit assumption that such choices will and should be efficiently pursued in the sense of efficient allocation of resources. For if alternative norms are incorporated into the social loss model and then judged in terms of this efficiency criterion, potential conflict arises: the norms are being judged on an altogether different basis from their original objective. To avoid this conflict 'efficiency' has to be assumed to be one of the initial goals of any norm incorporated.

CHAPTER 2

THE ROLE OF PUNISHMENT

2.1. Introduction

The purpose of Chapter Two is to outline the potential roles punishment is believed to fulfil, and the effect of their incorporation into the original social loss model.

Concentration is (still) placed upon the prescriptive social loss model, rather than a descriptive C.J.S. model. Firstly because the latter depends on the former: any policy conclusions about the efficiency of existing C.J.S. practices must be based on a theory of what the purpose of the criminal justice system is. Chapter Two reviews all the alternative theories of the C.J.S. purpose; in contrast previous economic studies have implicitly assumed only one purpose – if punishment is a price, it should therefore be a deterrent. Secondly, differences in the theories of punishment's role have practical implications: "deterrence, physical restraint, and the rehabilitation of the offender by treatment, are factors which courts have to take into account in deciding sentence. The law gives them no guidance on the weight to be given to each factor; and because of the divisions of public opinion and the great variety of circumstances they face in individual cases it would be infeasible for the law to do so"; SCOTTISH COUNCIL ON CRIME (1975)

Chapter Two illustrates that, assuming initial acceptance of a 'rational framework', it is possible to incorporate these different views about punishment's role into the basic economic model. However it is concluded that the problem of attaining 'the optimum' is still undetermined; as there is no

single accepted justification for punishment in theory, 'the purpose' of C.J.S. policy cannot be resolved in practice.

It may of course be argued that conclusions about the social less model should depend only on the correspondence of data with the hypotheses of theory: "viewed as a body of substantive hypotheses, theory is to be judged by its predictive power for the class of phenomena which it is intended to explain. Only factual evidence can show whether it (theory) is right or wrong or better tentatively accepted or rejected," M. FRIEDMAN (1971). However, to reiterate, no policy conclusions should be made without considering the relevance of the assumed purpose of the C.J.S.: "nothing can be considered sufficiently achieved until one discovers what the aim of the activity was " A.A. LEFF (1976). Furthermore even if the 'assumed purpose' of the C.J.S. may be viewed as a subset of the "body of substantive hypotheses", acceptance of this hypotheses depends, ultimately; on observed agreement to any change suggested by its implications – even if all the other hypotheses of the theory may 'correspond with the data'. Consideration of the assumed purposes of the C.J.S., and the role that punishment should therefore play, is developed below.

2.2. The Role of Punishment

P and f are the instruments through which C.J.S. policy is achieved. The possible purposes of the C.J.S. may therefore be indicated by outlining the possible roles that punishment may be believed to fulfil.

The distinction between facts and judgement is one of consensus. 'Facts' are expressions of thought that tend to hold wide consensus, value judgements do

not. In neo-classical economics value judgements are inclined to be ignored: 'efficiency' is assumed to have consensus approval: "efficiency is such a weak value, so widely believed to be desirable that it can be treated as if it were a purely factual concept", B WARD (1972). In this context "efficiency" means minimizing the social loss from crime. Punishment levels are set to obtain this end. But is this the role that punishment should play? The answer depends on one's values. Below are the opposing judgements on punishments role.

2.2.1. UTILITARIAN

In the economic theory of crime, punishment is a price. By increasing the probability of paying this price (p) or the price itself (f) the number of offences 'consumed' decreases. Punishment deters. The optimum punishment level is where the marginal benefit of reduced offences equals the marginal cost of enforcement.¹ However: "punishment that is imposed ex post cannot be a deterrent ex ante for the same offence" J.M. BUCHANAN (1975) ; actual punishments have no deterrent effect on the convicted offender. So should the relation between punishment and the punished depend on efficiency?

2.2.2. RETRIBUTIVE

The retributive view states that the severity of the penalty should equal the offenders culpability: the punishment should fit the crime. This implies the following.

First, retributive theory is the only theory which connects punishment with desert and so with justice. For only as a punishment is deserved or undeserved can it be just or unjust.² Second, one must determine that the accused actually committed the crime. For if punishments are fixed with

reference to past guilt one cannot (logically) punish the innocent. And, thirdly, in assessing past culpability reference may be made to the 'causes' of the offence. Some of the causes may be regarded as 'morally acceptable' justifications – punishments may take account of mitigating factors. In sum punishers should be concerned with those being punished, and not the effect of their penalties on others: "punishment can never be administered merely as a means of promoting another good for one man never ought to be dealt with merely as a means subservient to the purpose of another". F. ZIMRING and G. HAWKINS (1974).

2.2.3. REHABILITATIVE

This view holds that punishment should alter the offender's future behaviour: the probability of a convicted offender committing future offences should be reduced. Thus punishment should increase the future opportunity cost of crime for convicted offenders only. This effect could be incorporated in the social loss function by inclusion of the present discounted value of future benefits³ and costs of punishment. However, the deterrent effect works only if people act 'as if' they are rational. In contrast: "much crime and deviant behaviour may actually be caused biochemically and thus be truly irrational irresponsible behaviour" H.E. KELLY (1979); crime may be the outward sign of some physiological disorder – the offender can no longer be assumed to act 'as if' he or she is rational.⁴ Such offenders need medical treatment, rehabilitation (ex post) and not punishment (ex ante or ex post) acts as the 'deterrent'. So in some cases treatment (i.e. altering the individual's physiology) should be substituted for punishment. On 'efficiency' grounds the marginal cost of this treatment should equal the marginal benefit derived from reduced offences.

2.2.4. EXPRESSIVE

This view states that the law reflects society's norms: "every system of law stands in closest possible relation to the ideas, aims, and purposes of the society to which the law is to apply" W. ULLMANN (1966). No aggregation of people can function without some norms or conventions of behaviour and the law is the means by which these norms are translated into legal obligations and rules to which all should obey. From this viewpoint then, the purpose of law should be the promotion of 'social cohesion'; ideally the law should induce 'undeterred compliance' (i.e. adherence to the law even if p and f are zero). Thus laws would be effective if there were no punishments: punishment is a corollary not of law but of law breaking. However given 'law breaking', punishment is necessary. But punishment's central role is not to deter 'through fear' but rather to reaffirm norms of behaviour – punishment is a means of giving public recognition and encouragement to these norms in order that social cohesion (i.e. allegiance to these norms) is maintained.⁵ Finally, in this view, 'law breaking' is a result of the inadequate socialization to society's norms – the offender either does not know or does not accept certain legal rules. Therefore the 'solution' to crime is not punishment, for punishment is only the means by which a divided society maintains itself. 'The solution' is a change in the structure of society. The circumstances that cause 'inadequate socialization' should be altered: "public efforts to diminish or prevent socially undesirable conduct ought to be directed against the conditions which promote such conduct" J.F. DOYLE (1967). This would involve the determination of a set of values to which all members of society should and would subscribe, i.e. an ideal society.

In sum, order may be fundamental to society, law may be fundamental to

order, but ideally enforcement is not fundamental to law – there should be no role for punishment to fulfil. Thus the use of punishment is indicative of some basic flaws in society which punishment alone cannot correct.

The above shows there is no single accepted justification for punishment. If a legislator's justification is reductive (i.e. utilitarian), but the sentencer's is retributive and the penal agent's is rehabilitative, whose is 'the justification'. However, the above views do not stand in independent relation to one another. As shown below, some of the aims of punishment may be compatible, some incompatible.

2.2.5. RETRIBUTIVE in relation to UTILITARIAN

Retributive justice may be imposed as a constraint when setting 'optimum' punishment levels. This may involve:

- i. legal safeguards to protect the innocent from being punished⁶
- ii. a maximum punishment level for each offence type
- iii. allowance for mitigating factors in determining punishment levels
- iv. non-detention of potential offenders (detention would involve punishments for crimes that have not been committed).

Further, punishments imposed beyond these retributive limits may be destructive: they may alienate those who believe in justice, bring the law into disrespect, and thus interfere with the goal of prevention: "the justice and

decency of the law and its enforcement are not simply desirable embellishments, but rather the indispensable conditions of respect for law and civil peace in a free society". Final report of the NATIONAL COMMISSION ON THE CAUSES AND PREVENTION OF VIOLENCE (1969).

2.2.6. RETRIBUTIVE in relation to REHABILITATIVE

The retributive states that: "a wrongdoer has a right to be punished" H.B. ACTON (1969). Punishment signifies individual responsibility and therefore 'guilt' – treatment does not: "responsibility is best considered an artificial construct or myth we impose on people to influence or determine their behaviour in a direction we conceive desirable" S. HALLECK (1979). Retributive and rehabilitative views are not compatible. Behaviour control via medical treatment is not acceptable: an individual cannot be made 'better' if he is not 'sick' in the first place. And behaviour control via rehabilitative training (i.e. all non-medical treatment which increases the expected monetary and psychic returns from future legitimate ventures) is not acceptable: punishment is deserved. However, if physiological causes are accepted as 'mitigating factors' retributive justice may view medical treatment as the appropriate 'punishment'. In this case offenders are innocent.

2.2.7. REHABILITATIVE in relation to UTILITARIAN

As outlined above the rehabilitative view is compatible with the utilitarian: behaviour control should be optimal.

2.2.8. REHABILITATIVE in relation to the EXPRESSIVE

These views are not compatible. The rehabilitative wants to change the behaviour of the individual offender. Whereas, in the expressive case: "the target is not the delinquent act, nor the individual who commits it, but the

framework inside of which the delinquent is initiated and nurtured";⁷ the 'behaviour' of society should be changed.

2.2.9. EXPRESSIVE in relation to the UTILITARIAN

The expressive view shifts the emphasis of crime control from p and f – as changes in offences are regarded as relatively independent of p and f⁸ – towards measures to eradicate u – the causes of crime which are 'rooted in the overall social system': "the causes of most forms of deviance are in society (family, community, school, economic system) – therefore prevention and cure must lie in the community and not artificially created agencies constructed on a model of individual intervention" S. COHEN (1979); the circumstances that cause 'inadequate socialization' should be altered. This may be compatible with the utilitarian approach. The marginal cost of these changes could be equated with the marginal benefits derived from reduced offences. This assumes consensus about 'causes' and the value of costs.

2.2.10. EXPRESSIVE in relation to RETRIBUTIVE

The expressive view may be compatible with the retributive: 'mitigating factors' could include 'inadequate socialization'. This would indicate the need for a modification of social structures.

The above may be further amalgamated. Either, physiological causes can be identified (rehabilitative), the 'innocent constraint' is adopted (retributive), and treatment is optimal (utilitarian). Or, 'inadequate socialization' (expressive) is regarded as a mitigating factor (retributive) and social reform is optimal (utilitarian). Each position above provides a justification and motive (s) for punishment. As a result each position also provides an explanation of the

C.J.S. itself. However their relevance in practice depends on the reaction of people to actual punishment levels. For just as no pronouncements on the efficiency of existing C.J.S. practices can be made without looking at what these practices hope to achieve, then no pronouncements on what C.J.S. practices hope to achieve can be made without looking at what they actually achieve. Paradoxically peoples reactions can only be interpreted in the light of theory: "direct measurements depend upon theoretic assumptions" M.A. COHEN quoted in M. BLAUG (1981). In turn what theoretical model to adopt depends on the above positions. This may be illustrated by analysing the affects on the basic economic model that result from consideration of the 'other roles' of punishment. This assumes (to reiterate chapter 1) at least partial acceptance of the economic approach in determining C.J.S. policy.

2.2.11. RETRIBUTIVE CONSTRAINTS⁹

Retributive theory states that only the guilty should be punished. As indicated above this implies the imposition of the following constraints in the utilitarian model: legal safeguards; maximum punishment levels and mitigation.

Legal safeguards to protect the innocent from being punished leads to two additional costs in the original social loss function: the cost of erroneous convictions, and the cost of legal safeguards to prevent such convictions. The social loss from erroneous conviction (R), which include the direct cost to the innocent person convicted, and the indirect cost of the reduction in societal welfare due to the 'unjust' punishment, may be assumed to be a function of the probability of wrongful conviction (p_r), punishment per offence (f) and the total number of offences committed (O):¹⁰

$$R = f(p_r, f, O) ;$$

(25)

where

$$Rp_r, R_f, R_O > 0;$$

(25a)

increases in the severity of (unjust) punishment or the numbers of people being wrongfully punished (through increases in p_r or O) increases the social cost of mistakenly punishing the innocent. The probability of wrongful conviction may be assumed to be a function of the probability of conviction (p) and the level of legal safeguards (α):

$$P_r = f(p, \alpha) ;$$

(26)

where

$$\frac{\partial p_r}{\partial p} > 0 \quad \frac{\partial p_r}{\partial \alpha} < 0 ;$$

(26a)

for a given level of offences and costs of apprehension, increases in p increase the likelihood of wrongful conviction whereas increases in legal safeguards to prevent conviction of the innocent (as reflected by higher values of α) lead to reductions in p_r . Finally, the costs of apprehension and conviction may be assumed to be positively related to α :

$$C_\alpha > 0$$

(27)

i.e. the costs of apprehending and convicting a given percentage of offenders

at a given level of offences will be lower without legal safeguards than it would be with them. Thus, the social loss function may be respecified:

$$L = D(O) + C(O, p, \alpha) + R(p_r, fO) + bpfO \quad (28)$$

and the first order conditions for social loss minimization, given (5a), are:

$$D' + C' + R' + R_f \frac{1}{O_f} = -bpf \left(1 - \frac{1}{\epsilon_f}\right) \quad (29)$$

$$D' + C' + R' + \left(C_p + R_{p_r} \frac{\partial p_r}{\partial p}\right) \frac{1}{O_p} = -bpf \left(1 - \frac{1}{\epsilon_p}\right) \quad (30)$$

Relative to the original optimum conditions (8a and 9a), the marginal cost of reducing f and p – in equations (29) and (30) – is reduced by a factor of $R_f 1/O_f$ and $R_{p_r} \partial p_r / \partial p \cdot 1/O_p$ respectively (i.e. as f and p fall the severity of unjust punishment and the probability of an innocent person being punished fall) and it is increased by a factor of R' (i.e. as f and p fall offences increase therefore more innocent people are punished). If the relative effect of the R function is negative, (from the innocent but potentially wrongly convicted viewpoint the marginal cost of being mistakenly convicted increases as p and f rise whereas the rise in marginal benefit from reduced offences that results declines), then the social losses from 'unjust' punishment are more sensitive to changes in p and f than a change in O and therefore:

$$D' + C' > D' + C' + R' + R_f \frac{1}{O_f} \quad (31)$$

$$D' + C' + C_p \frac{1}{O_p} > D' + C' + R' + (C_p + R_p \frac{\partial pr}{\partial p}) \cdot \frac{1}{O_p} ; \quad (32)$$

relative to the original optimum, the new optimum level of offences will now be HIGHER and the new optimum level of p and f will be LOWER.¹¹ Hence the cost of protecting the innocent is a higher level of offences.¹²

The second retributive constraint that may be imposed is 'maximum punishment' (f_{max}). Assuming that social loss minimization is the overriding principle that governs C.J.S. policy, (otherwise f will always be set at f max) optimum conditions are as follows. The original social loss function is now subject to the constraint:

$$f < f_{max} ;$$

i.e. punishment levels cannot exceed the maximum level of punishment set by retributive limits. The social loss function may therefore be reformulated:

$$\alpha = D(O) + C(O,p) + bpfO - \lambda(f - f_{max}) ; \quad (33)$$

and the first order conditions for a minimum are now:¹³

$$\frac{\partial L}{\partial f} = D'O_f + C'O_f + bpf_{-O_f}^1 + bpO - \lambda > 0 \quad \text{if } \frac{\partial L}{\partial f} - \lambda = 0, f > 0 \quad (34)$$

$$\frac{\partial \alpha}{\partial \lambda} = f - f_{\max} < 0 \quad \lambda f - f_{\max} = 0, \lambda > 0 ; \quad (35)$$

given f^* is the original unconstrained optimum level of punishment, if $f^* < f_{\max}$ (i.e. the optimum level of 'deterrent' punishment falls below the maximum level of retributive punishment) social losses may still be minimised (i.e. $\frac{\partial L}{\partial f} = 0, \lambda = 0$) This also holds if $f^* = f_{\max}$: the optimum level of 'deterrent' punishment is equal to the maximum level of retributive punishment. However if $f^* > f_{\max}$ social losses cannot be minimized. In this case punishment levels will be set below the original optimal level at f_{\max} and the offence level will therefore be higher than the original level (i.e. $\frac{\partial L}{\partial f} > 0, \lambda > 0$). Thus λ represents the shadow price of justice and "the demand for justice is not independent of its price", R.A. POSNER (1975). The 'price' of imposing maximum punishment levels is therefore not only a HIGHER level of offences (compared with the original optimum level), but also an excess of the marginal costs of criminal activity over the marginal costs of enforcement: $\frac{\partial L}{\partial f} > 0$. But of course a retributive limit on punishment is imposed precisely because: "no excess of social benefits over social costs would be permitted to justify punishing the offenders as a means of some greater social good." R.C. COFFEE (1978).

The final retributive constraint is that of 'mitigation' – punishers should set punishment levels with reference to offender's 'culpability'. If account of

'mitigating factors' is regarded as 'price discrimination' it may be incorporated into the loss function. This assumes the following. One, that it is possible to separate the 'total market' for offences into 'submarkets' that differ significantly in terms of their 'elasticity of demand' for offences. And two, these differences are related to differences in 'culpability'. For example, for a given offence, offenders who 'intend' to commit a 'crime of passion' may be less responsive to a given expected punishment, than those who intend to commit a 'premeditated crime'. In the same instance, the former may be regarded as less culpable than the latter: "if some people perform a prohibited action with calculated deliberation and others perform the same action on impulse or in passion, we regard the former as morally worse and as deserving a heavier penalty", C.W.K. MUNDLE (1954).

In the simple case of two submarkets (O_1 and O_2), the social loss function may be respecified:

$$L = D(O_1 + O_2) + C(O_1 + O_2, p_1, p_2) + bp_1f_1O_1 + bp_2f_2O_2 ; \quad (36)$$

to take account of the (assumed) differences in responsiveness. (i.e. $\epsilon f_1 = \epsilon f_2$ and $\epsilon p_1 = \epsilon p_2$). The first order conditions for social loss minimization given (5a) are:

$$D'_{1+2} + C'_{1+2} = -bp_1f_1 \cdot 1 - \frac{1}{\epsilon f_1} = -bp_2f_2 \cdot 1 - \frac{1}{\epsilon f_2} \quad (37)$$

$$D'_{1+2} + C'_{1+2} + Cp_1 \frac{1}{op_1} + Cp_2 \frac{1}{op_2} = -bp_1f_1 \cdot 1 - \frac{1}{\epsilon p_1} = -bp_2f_2 \cdot 1 - \frac{1}{\epsilon p_2}$$

(38)

i.e. the marginal cost of enforcement in each submarket should equal the marginal cost of total offences. Further, if the 'elasticity of demand' is more inelastic in market two than market one, then,

$$1 > \epsilon_{f1} > \epsilon_{f2}$$

(39)

$$1 > \epsilon_{p1} > \epsilon_{p2} ;$$

(40)

and therefore

$$0 > 1 - \frac{1}{\epsilon_{f1}} > 1 - \frac{1}{\epsilon_{f2}}$$

(39a)

$$0 > 1 - \frac{1}{\epsilon_{p1}} > 1 - \frac{1}{\epsilon_{p2}}$$

(40a)

which given (37) and (38) implies:

$$p_1 f_1 > p_2 f_2 ;$$

(41)

expected punishment levels will be LOWER in those markets where the 'elasticity of demand' with respect to p and f is inelastic relative to other

markets. Thus $f_1 > f_2$ and $p_1 > p_2$ ¹⁴ which corresponds with retributive theory, although not for the same reasons. The retributive believes that the less culpable deserve a smaller punishment, whereas the economic approach dictates a lower sentence, since a higher expected punishment would not minimize social losses – the marginal costs of enforcement would exceed the marginal costs of criminal activity.

2.2.12. REHABILITATIVE CONSTRAINT.¹⁵

As outlined above the rehabilitative view – that offender's future behaviour should be altered – can be incorporated into the social loss function. This is achieved by inclusion of the present discounted value (P.D.V.) of the future costs and 'benefits' of 'punishment'. Thus, if:

I = P.D.V. of the net cost of imprisoning current period offenders

B = P.D.V. of the net cost of crimes committed by current offenders after their release

t = intensity of rehabilitative 'training'

f = duration of punishment and therefore 'training'

N = O.p.f., total number of man years training

δ = fixed rate of social time preference;

where

I = $f(t, N, \delta)$

(42)

$$B = f(t, N, \delta) ;$$

(43)

and

$$I_t, I_N > 0 ;$$

(44)

i.e. increases in the intensity or duration of training increases the P.D.V. of the net costs of imprisonment. Whereas,

$$B_t, B_N < 0 ;$$

(45)

increases in the intensity or duration of training are 'beneficial' in that they reduce the P.D.V. of the net cost of future crimes: less (future) crimes are committed as a result of rehabilitative training. The social loss function may be respecified:

$$L = D(O) + C(O,p) + I(t, N, \delta) + B(t, N, \delta) ;$$

(46)

thus the first order conditions for social loss minimization given (5a) are:

$$D' + C' = -pf(I_N + B_N) \left(1 - \frac{1}{\epsilon_f}\right) \quad (47)$$

$$\frac{D' + C' + C_{pOp}}{1 - \frac{1}{\epsilon_p}} = -pf(I_N + B_N) \quad (48)$$

$$I_t = -B_t ; \quad (49)$$

equations (47) and (48) do not differ from the original optimum conditions (8a) and (9b) if it is assumed that $b = I_N + B_N > 0$. Thus the rehabilitative view only 'imposes' an additional optimum condition - (49). Rehabilitative training should be optimal: the net marginal cost of providing this training (I_t) should be equal to the net 'marginal benefit' realized by the reduction in future crimes that such training produces ($-B_t$).

These conclusions however implicitly assume that imprisonment, viewed as a period of investment in human (i.e. offenders) capital only pays 'positive' returns from the point of view of society (i.e. $B < 0$). Typically however a prisoner will experience both 'positive' investment through rehabilitative training and 'negative' investment through a 'criminogenic effect': "in prison the period of human capital formation ordinarily makes the convict even more adept at earning easy money in property crimes" A. KROHM (1973). So if recidivism predominates $B > 0$ and over all values of p and f , $b > 0$. Moreover, even if investment does yield positive returns this may reduce the

deterrent effect of imprisonment for potential offenders. For if rehabilitative training increases the opportunity cost of crime for released offenders by increasing the expected monetary and psychic returns from legitimate ventures, then it may reduce the opportunity cost of crime for potential offenders. Should this occur, given:

$$O = f(t, \dots) \quad \text{where } \partial O / \partial t > 0 \quad (50)$$

then

$$\frac{\partial L}{\partial t} = D' \partial O / \partial t + C' \partial O / \partial t + I_t + I_n (\partial O / \partial t \cdot pf) + B_t + B_n (\partial O / \partial t \cdot pf) = 0 \quad (49a)$$

i.e. relative to the original optimum (49) net marginal costs are increased due to increased present offences and net 'marginal' benefits are increased by the increase in total training that results.

2.2.13. EXPRESSIVE CONSTRAINT

The expressive holds that the conditions which cause crime (u) should be altered. This view may be incorporated into the economic approach as follows. Assuming that u can be identified:

$$O = f(u, \dots) \quad \text{where } O_u > 0; \quad (51)$$

and further, these causal conditions can be alleviated (i.e. 'reduced') by an

increase in the resources devoted to 'remedial social programs' (S_p):

$$u = f(S_p) \text{ where } u_{S_p} < 0 :$$

(52)

and finally, the cost of increasing resources devoted to these programs is positive:

$$C = f(S_p) \text{ where } C_{S_p} > 0 :$$

(53)

then the social loss function may be reformulated:

$$L = D(O) + C(O,p) + C(S_p) + bpfo$$

(54)

The first order condition for social loss minimization with respect to S_p given (5a) is:

$$(D' + C' + bpf) O_u = -C_{S_p} \frac{1}{\partial u / \partial S_p} :$$

(55)

i.e. the marginal cost of increasing social programs directed at alleviating the causes of crime should be equated with the marginal benefit derived as reflected in costs from reduced offences.

2.3. Conclusion

In contrast to previous economic models of the C.J.S. the above shows that different views about the purpose of punishment, other than deterrence, may be incorporated into the original social loss model. In turn, such incorporations provide a set of different perspectives from which to interpret actual practices. In doing so however the problem arises of obtaining 'the optimum' (as opposed to a series of alternative optimum practices). For since the C.J.S. serves other goals apart from deterrence, any conflict among these goals cannot be resolved on utilitarian grounds alone: economic theory cannot prescribe what values one should adopt; punishment levels based on the economic approach alone may be 'efficient' but this does not mean one will wish to implement them. Thus it is only through general acceptance of one, or more of the above constraints that determines what it is one should try to minimise using the framework of the social loss function (and this assumes acceptance of this rational framework in the first place).

While it is possible therefore to progress from the limited perspective of previous economic analyses, the apparent indeterminacy of the resultant theoretical models might appear to justify such limitation. But to understate, or ignore altogether, the problem of resolving different choices of the C.J.S. purpose, because of the absence of consistent views about the role of punishment will inevitably limit the acceptance, and part that economics should play in determining C.J.S. policy. It may not be possible to prescribe 'the optimum' system, but whatever the ethical constraints of the society in which the C.J.S. operates, it is possible to predict the outcome of alternative views, and their difference in terms of efficient resource allocation, through the analytical framework of the social loss model.



In short it is theoretically possible to use this framework to assess the efficient allocation of C.J.S. resources without necessarily assuming that offenders respond to changes in expected punishment. However, in the context of economic analysis, the social loss model proposed does depend fundamentally on this response. From this narrower perspective therefore the issue of deterrence is still crucial: is there a negative correlation between expected punishment and the offence rate? This question is addressed in subsequent chapters.

CHAPTER 3

ECONOMETRIC STUDIES OF THE CRIMINAL JUSTICE SYSTEM

3.1. INTRODUCTION

Chapter Three provides a critical analysis of previous econometric studies of the Criminal Justice System.

To complement Chapter One and Two the links are outlined between the formal (prescriptive) economic theory and applied (descriptive) economic models. Concentration is therefore placed on the role of a priori theory in determining the empirical specification of the supply of offences function. Obviously a separate, but not unrelated issue, concerns the demand for criminal justice system services. Traditionally econometric studies have either incorporated an aggregate 'production function' within a simultaneous model, or focussed entirely upon disaggregating police production processes within a recursive rather than simultaneous framework. In this study the former approach is adopted both from choice (i.e. the importance of the assumed response to punishment) and practical necessity due to the insufficiency of data concerning actual police practices. As D.J. PYLE (1983) concluded, the development of the police production function has largely foundered because: "the data which investigators have been working with is inferior to the techniques which are available. Any further progress must be in the refinement of data rather than techniques".

From the assessment of the links between the formal and applied (supply) models, in conjunction with a summary of the results obtained, a detailed analysis is undertaken of the problems involved in determining the existence

(or not) of a deterrent effect. It is concluded that many of these problems occur because of the paucity of formal theory in providing a basis for empirical specification – initial theoretical assumptions therefore also constrain economists ability to model the C.J.S. itself.

In light of this conclusion and the problems outlined, comment is made on the validity of economic models in contributing to actual policy decisions. Not surprisingly, in the context of this study, it is argued that despite all the problems, economics should play a role in determining short term policy. Finally, and more obviously, by outlining such problems, potential rectification in the present study is increased.

3.2. ECONOMETRIC MODELS

The linkage between formal and applied models is direct: theory provides the basis for empirical specification: "all observations are really interpretations in the light of theory", M. BLAUG (1981); i.e. there is no thief unless somebody thinks so. Hence as a result of the economic theory of crime models of the C.J.S. and analysis of deterrence have the following three common attributes.

3.2.1. AGGREGATE CRIME RATE FUNCTIONS

Economics is concerned with examining the results of people's actions not explaining the actions themselves. The economic theory of crime therefore does not attempt to explain why any one individual commits crime, instead it focusses attention exclusively on the opportunities that confront offenders (through changes in p , f , and u). Models of psychological processes which describe how environmental inputs effect criminal behaviour directly are bypassed in favour of aggregate crime rate functions which only attempt to measure the effects of observed sanctions and (some) socio-economic

variables. Differences in individuals tastes for crime are ignored because in theory tastes are assumed constant. This does not preclude that peoples actual attitudes to committing crime are different. Rather it assumes these preferences are stably distributed and unrelated to observable changes in the measurable incentives that confront all potential offenders. Consequently changes in p , f , and u must account for changes in aggregate crime levels and be modelled accordingly.

3.2.2. SIMULTANEOUS EQUATION SPECIFICATION

This is used in order to emphasize and allow for the assumed theoretical feedback mechanism of crime upon the criminal justice system and vice versa. For in the economic model, C.J.S. activity is not only determined by, but is also a determining factor of the level of crime (i.e. $C_o, C_p > 0$ and $O_p, O_f < 0$). The inputs of the C.J.S. are combined to produce an output: expected punishment. The allocation of these inputs and their effectiveness via output levels is therefore determined by while simultaneously being a determinant of offence levels.

3.2.3. LOG-LINEAR SPECIFICATION

This is used for two reasons. First, the deterrent effects of punishment and the certainty of punishment are not additive: in the absence of 'infinite fines', punishment with no probability of enforcement has no deterrent effect and vice versa. Second, to determine the relative effectiveness of sanctions, E_p and E_f , and therefore their correspondence with the theoretical predictions of the economic model (i.e. $1 > \epsilon_p > \epsilon_f$ at the 'optimum' – see chapter one).

The results obtained from models adopting these attributes are well documented elsewhere: D. BEYLEVELD (1978); A. BLUMSTEIN, J. COHEN, and

D. NAGIN (1978) and D.J. PYLE (1983). In summary they indicate:

- (a) a consistent and significant negative relationship between crime rates and arrest rates, clearance ratios and sentence lengths, with elasticities of offences with respect to those variables tending to fall within the range of 0 and -1;
- (b) an elasticity of offences with respect to the probability of certainty larger than that with respect to the probability and level of punishment;
- (c) significant, although not always consistent, relationships between crime rates and measures of opportunity cost and illegal gains with elasticity values that indicate potential offenders may be more responsive to these factors than punishment variables; and,
- (d) no consistent relationship between expenditure and crime rates and arrest ratios, implying within the limitation of an aggregate 'production function', that changes in crime levels have differing impacts upon the efficiency of police forces at different times.

While these results are broadly consistent with the predictions outlined in Chapter One before they may be considered as useful with regard to determining the actual response of potential offenders, the accuracy of the methods used to obtain such results has to be analysed. Do such methods demonstrably overcome the conceptual and practical problems they face? Examined below are the difficulties that result from adoption of the basic

attributes above. For only from examination of these problems, common to all studies, is it possible to decide whether such research provides results that should influence policy decisions. Furthermore their investigation provides a foundation for this study and a basis for comparative analysis.

3.3. IDENTIFICATION

In Becker's theoretical model, C.J.S. resources display diminishing marginal productivity (i.e. $C_{pp} > 0$ and $C_{oo} > 0$). This implies that, ceteris paribus, a 'random' increase in offences will reduce the probability of conviction, and, ceteris paribus, an increase in the resources devoted to apprehension and conviction will increase this probability:

$$p = f(O, c) \quad (56)$$

where

$$P_o < 0, \quad p_c > 0; \quad (56a)$$

however, if the above holds any observed negative association between crime rates and sanctions may be a result of $P_o < 0$ rather than $O_p < 0$. Further, if it is assumed that the purpose of the C.J.S. is 'to deter crime', any random increase in offences will lead to an increase in the resources devoted to the C.J.S. (in order to return to 'the optimum'). Again this effect has to be separated from any deterrent effect, before changes in O can be attributed to changes in C.J.S. resources via p . Thus, at minimum, the following

relationships hold:

$$O = f(p, f, u), \quad O_p, O_f < 0$$

(5, 5a)

$$c = f(O, p), \quad C_O, C_p > 0$$

(2, 2a, 2b)

$$p = f(O, c), \quad P_O < 0, p_c > 0;$$

(5b, 5b)

the identification problem: "is that of separately identifying these relationships from a data sample in which they are compounded by the operation of the interactive system described;" B. J. HILTON (1981) i.e. how does one separate what causes changes in O from what results from changes in O ? The solution is to impose 'identification restrictions'. Unfortunately the economic theory of crime gives no indication what to include or exclude from the above relationships. It is this lack of formal theory which makes decisions about identification of necessity appear arbitrary, although not necessarily incorrect: "statistical inference unsupported by economic theory applies to whatever statistical regularities and stable relationships can be discerned in the data. Such purely empirical relationships when discernible are likely to be due to the presence and persistence of underlying relationships, and (if so) could be deduced from the latter"; T.C. KOOPMAN (1953).

Three kinds of identification restrictions have typically been used to identify

the crime rate function:

1. Socio-economic and demographic measures
2. Crime rates other than the one under investigation
3. C.J.S. expenditure

Some critics e.g. F.M. FISCHER and D. NAGIN (1978), believe there is no basis for using (1). Restrictions should be based on a priori grounds. But since the economic theory of crime gives no indication as to what should be excluded then there appears to be no 'validated' grounds upon which to exclude (1). So for example there may be no grounds for excluding: unemployment rates of males between 35-39, I. EHRLICH (1973); fraction of non-whites in the population, P. PASSEL and J.B. TAYLOR (1977); and the proportion of the population that is middle class, R.A. CARR-HILL and N.H. STERN (1979). In this view using (1) is at best arbitrary and at worst data mining. Using (2) depends on the validity of assuming that other crime rates have no direct effect on the crime being examined. While a reasonable assumption in some cases - e.g. minimum wage law-violations, L.C. THUROW and C. RAPPAPORT (1969) - it does not appear feasible when investigating other crime types (e.g. theft). As already noted (in chapter one) these crimes may have substitutes and/or complements. Use of (3) does appear valid. First it is only through the 'output' of the C.J.S. and not the inputs that a deterrent effect is expected. Second, although the allocation and the level of these inputs are assumed to be influenced by the crime rate, due to local and central government budgetary cycles current expenditure may be assumed to be largely predetermined by the crime rates of prior periods.

Given that: exclusion is based on relative not absolute terms, identification restrictions cannot be tested using the data generated by the model investigated; and a limited number of empirical variables available, then it might well appear that restrictions are somewhat arbitrary and that results could therefore be biased. However to dismiss all econometric results on such grounds is not valid. The strength of the economic approach over alternatives lies in its ability to accommodate the analytical problems involved in stressing the complex nature of the C.J.S. Given the simultaneity problem absolute certainty of econometric results can never be claimed. Rather their relative consistency and likelihood, having taken account of this problem, is. However, given existing criticism, this study uses alternative restrictions namely: lagged crime rates and prison capacity rates.¹ The validity of the existing framework may therefore be judged by whether or not significantly different parameter estimates result.

3.4. CONTROL VARIABLES

In theory the crime rate function is not only dependent on p and f but also u ('other factors'). Thus u itself has to be specified in order to eliminate potential distortions in the measurement of any 'deterrent effect'. Inspection of (6c):

$$U_i(Y_i) < (1 - p)U_i(Y_i) + pU_i(Y_i - f) ;$$

(6c)

would suggest that any factors which increase $U_i(Y_i)$ (i.e. increase the opportunity cost of crime), or reduce $U_i(Y_i)$, (i.e. reduce the potential gains from crime) will reduce the number of offences committed since the number

of people for which (6c) holds will fall.² Thus it is necessary to introduce measurable proxies for 'opportunity cost' and 'potential gains' into the aggregate crime function. Further, if 'tastes are assumed constant' it is only differences in individuals's objective circumstances (i.e. differences in the 'opportunities' for criminal endeavours) that need be accounted for by these proxies. Alternatively, if taste variables are introduced it must be assumed that people also differ in their 'subjective' circumstances (i.e. people differ in their attitudes towards crime and hence have different 'subjective' utility functions). However, the choice of what 'taste variables' to include in u , must be based on, at least partial, acceptance of an alternative theoretical model of criminal behaviour. For, again, the economic theory of crime can give no indication as to what 'taste variables' to use: tastes are assumed constant. Thus the first problem involved in deciding what to include in u is as follows. Either one accepts that 'tastes are assumed constant' on the grounds that the validity of the economic model depends on the relevance of its predictions alone. Or one accepts that tastes may play a causal role (on the grounds that: "... you cannot make 'other variables' go away by just ignoring them. If they really are casual factors in the problem, they are still operating, and identification by selection merely leaves the scientist, attributing part of their effect to the variables he decided to include", B. WARD (1972)), and therefore base one's empirical specification on an amalgam of theoretical models thereby incur the resultant problems of conflicting specification and identification.³

Having made the choice between constant and differing tastes, the aggregate control variables used tend to fall into four groups.⁴ Where tastes are assumed constant only 'opportunity cost' and 'potential gain' measures are necessary.

These have included:

1. OPPORTUNITY COST: % unemployed; real personal disposable income per capita; % of families below half of the median income; % earning less than \$3000 (1960); estimates of permanent real income per capita; proportion of the population that is 'working class'; % of negroes; % of non-whites; total rateable value per acre; average per capita assessed valuation of property; median school years completed; % males married; and infant mortality rate.

2. POTENTIAL GAINS: per capita income; median income; % of families below half of the median income; % earning less than \$3000 (1967); gini co-efficient; total consumer expenditure; unemployment rate; population density per square mile; proportion of the population living in cities of 25,000 or more (USA 1960); proportion of the population living in cities of 20,000 or more (Florida 1971); population per occupied household; % of women in labour force; % of houses valued at greater than \$20,000 (New York 1972); average property values; average rateable values; combined receipts of wholesale, retail and service establishments; median education; % of population in manufacturing occupations; and the weight of the lightest T.V. set.

Where studies have attempted to account for changes in 'tastes', the above have been supplemented with measures for 'the propensity to consume offences' and 'social conditions':

001. PROPENSITY TO CONSUME OFFENCES: proportion of the population between 15-30; proportion of the population between 15-24; % of the population that is male; unemployment rate of urban males 14-24; % of married males; % of families with both husband and wife; % of night time population under 25; % of the population aged 65 or over; and the sex ratio of 15-49 years old.

002. SOCIAL CONDITIONS: time trend; % of blacks; % of foreign born; ratio of net-non white immigrants in previous ten years to total population; unrelated individuals per population; dummy variable for Southern U.S. States; and average temperatures.

Several problems arise from the use of these control variables.

First multi-collinearity: there appear no directly separable measures of opportunity cost and potential gains. For instance does the unemployment rate measure the 'opportunity cost of crime'; as it rises crime rates would be expected to rise. Or does it measure the potential gains of crime - as it rises crime rates would be expected to fall. Second, a priori judgements and data limitations determine which control variables are used. However exclusion of some variables may bias results. Serial independence only holds if the effects of excluded variables are assumed to vary randomly over time. With reference to excluded socio-economic and demographic variables this may appear unreasonable - they may only change gradually with time. Third, in time series estimation structural homogeneity is assumed: the underlying structure of social attitudes is assumed to be constant. Is this plausible? For example,

P. PASSEL and J. B. TAYLOR (1977) compared I. EHRICH'S (1973) 1935-68 U.S. murder rate equation with an exactly similar specified 1935-62 equation. An F-ratio test was significant at the 99% level - the hypothesis of structural homogeneity was rejected. Obviously some studies have attempted to counter this problem by introducing (3) and (4). However as already stated this leads to problems of conflicting specification and interpretation.

Judgement is essential therefore in determining what control variables to use: "Where a variable is excluded the implied judgement is that the arguments for including it are weak or non-existent. We have no alternative to making such judgements if we are to estimate". R.D. CARR-HILL and N. STERN (1979). So initial agreement as to what control variables measure what is unlikely. As a result reliance upon judgement alone is inadequate. To counter the above problems it is necessary to compare different studies results. Accumulated empirical verification of a control variables direction of effect provides a basis for agreement as to what it measures. Furthermore, since different studies use different statistical techniques, time periods, areas investigated, and control variables comparisons should also indicate the robustness (or not) of any particular measures predictive power. Finally, attention should be drawn to the purpose of econometric studies of the C.J.S. It is to discern evidence of any marginal deterrent effects over the range of penalties typically imposed. Any such evidence therefore provides a basis for short term ('short-cut') policy proposals for a GIVEN legal framework and a GIVEN society via the reduction of the OPPORTUNITIES to crime. But by focussing on the short term impact of the changes in the C.J.S. it cannot provide an overview of the effects of long term social change. Obviously the longer the time period considered the more fundamentally important these social changes may be, and so the less useful

the whole economic approach becomes. However by implication and purpose these forces (i.e. (3) and (4)) lie outwith the scope of econometric studies.

3.5. CERTAINTY AND SEVERITY INDEXES

In Becker's theory, potential criminals are assumed to have 'perfect' foresight – objective measures of sanction levels are assumed to accurately reflect the population's perceptions of these sanctions. This implies that current indexes of certainty and severity should be used as measurable proxies for p and f . However there are various arguments which oppose this view suggesting instead that objective punishment levels may differ from perceived levels, and therefore that:

$$p_a = f(p, \dots)$$
(57)

$$f_a = f(f, \dots)$$
(58)

where:

P_a = actual perceived certainty of punishment

f_a = actual perceived punishment

First, if 'deterrence' is viewed as a mechanism of information transmission, there may be reasons for substantial delays in the transmission of this information (e.g. delays in court cases, changes in police procedures unknown to the public etc.). Secondly, subjective and objective assessments of p and f may never be identical. As already noted (in chapter one) punishment may

have 'social consequences'. So if statutory punishment does underestimate actual perceived punishment then estimates of the elasticity of statutory punishment will undermeasure the elasticity of 'total' punishment.⁵ Alternatively, LERICKSON, JENSEN and GIBBS (1972) postulate that individuals perceive expected punishment in terms of 'what ought to be' - expected punishments for 'serious' crimes should be relatively high and are therefore believed to be irrespective of their objective values. Others argue that expectations about future sanction levels are relevant in determining potential offenders perceptions.

The relevance of these arguments in determining any 'deterrent effect' is as follows. If the assumption of perfect foresight is dropped then: "unanticipated increases in law enforcement activity cannot reduce the level of criminal activity except through an incapacitating role" K.I. WOLPIN (1978); only perceived changes in p and f (i.e. through p_a and f_a) can be of 'deterrent value'. In sum empirical formulations based on the assumptions of perfect foresight may not provide an appropriate test of deterrence. But on the other hand how is it possible to determine which changes in p and f are 'perceived' and which are not? The choice of alternative theoretical models of expectations is numerous: "There is one set of correct expectations based on complete knowledge but there is an endless variety of incorrect ones", M. BLAUG (1981). The 'appropriate' formulation is of necessity based on a subjective choice - on an aggregate basis potential offenders estimates of sanction levels are unknown.

Given the above various indexes have been used:

1. CERTAINTY: number of arrests per population; number of arrests per reported crime; number of convictions per reported crime; number of prison admissions per reported crime; number of admissions in year t per number of average reported crimes ($t - 1$ to t); average number of admissions (t to $t - 5$) per number of average reported crimes ($t - 1$ to $t + 4$); number of convictions per reported arrest; and percentage of known offences cleared by arrest.
2. SEVERITY: mean sentence length of those released in year t ; median sentence length of those released in year t ; mean sentence of those sentenced in year t ; and two, three, four and five year moving averages of sentence length.

In deciding on the choice of index further practical problems arise. First, it must be assumed when using aggregate data that objective measures of sanction levels accurately reflect the populations perception of these sanctions. As stated above which index meets this requirement is a matter of subjective choice. For example, T. ORSAGH (1979) argues that expectations about future sanction levels are relevant. Whereas others question the use of data which relates measures of certainty and severity to past crime rates: this appears to violate the logic of deterrence whereby: "reduced criminality or deviance is expected to follow the imposition of a certain or severe punishment", T.G. CHIRICOS and G.P. WALDO (1970). Secondly, sanction variables and offence rates should refer to the same population. As P.J. COOK (1977) notes average prison sentences are applicable only to adult offenders,

so they should not be related (as they are in most U.S. studies) to adult and juvenile offence rates. Further C. F. MANSKI (1978) questions whether offenders are homogenous enough in the sanctions they face to justify macro-crime supply functions. For example the probability of expected punishment for murder may range from near zero (gang land executions) to near one (family murder). Furthermore, official punishment, although similar in length may not be similar in effect due to differences in the 'consequences of conviction' upon each offender, and differences in individual prison regimes. Third, and finally, it is difficult to account for multiple crimes committed by the same person. Indexes only yield the probability of all crimes cleared. The probability per individual crime is not known.

The problem of how to model expectations is unlikely to be resolved - potential offenders expectations of punishment are unknown. The use of current (or near current) indexes in this study is therefore justified on the following (subjective) grounds. Any systematic gaps between perceptions and reality would presumably force potential offenders to revise their perceptions in the direction of actual levels. Secondly, the effects of incapacitation can be accounted for (see below). Thirdly, K.L. AVIO and C.S. CLARK (1976) found when crime rates fell the average sentence of current releases increased because the prison population became heavily weighted with 'long-timers'. They avoided this problem (of spurious correlation) by using current sentence data. Finally, as T.G. CHIRICOS and G.P. WALDO (1970) pointed out the logic of deterrence implies that reductions in crime are likely to FOLLOW changes in expected punishment. Without monthly data the lags in the effect of changes in punishment cannot be clearly specified. However current annual indexes will to some extent incorporate this 'follow on' effect, and clearly the effect of

changes in expected punishment is likely to diminish the further back past punishment levels are related to current crime rates.

Turning to aggregation. By definition aggregate crime rate functions involve the use of average sanction data. While this had led critics to question the relevance of specifying an aggregative model given "no formal bridge between cosmic utility analysis and national supply functions"; KLEIN ET AL quoted in B. BLUMSTEIN, J. COHEN and D. NAGIN (1978), the econometric approach cannot specify the effects upon any particular individual or group passing through the C.J.S. The alternative – splitting potential offenders into 'relatively homogeneous groups' – while theoretically possible is practically implausible. For while the expectations of these groups towards changes in C.J.S. policy and resultant response to these expectations may be modelled in theory, in practice this assumes a prior knowledge of actual sanctions faced per group, and therefore the division of the relevant population set of potential offenders into relatively similar groups by crime type.

Finally in 'macro' studies, the problem of multiple crimes must be noted. In 'micro' studies⁶ it may be possible to correct: R. THALER'S (1977) clearance rate defines a crime cleared only if a criminal is arrested specifically for that offence.

3.6. INCAPACITATION

Given prison sentences any negative association between crime and sanctions may reflect the combined effects of deterrence and incapacitation. For the length of a prison sentence, confinement incapacitates the convict from committing any criminal act(s) he or she might otherwise have chosen to

undertake. If incapacitation does reduce crime then omitting this factor will upwardly bias the deterrent effect of formal sanctions.

Various models have been developed which show that, by assuming a level of crime that would have been committed had imprisonment been avoided, it is possible to isolate the deterrent from the incapacitative effect.⁷

There are two problems with the above. First, accurate estimates of the incapacitative effect depend on the ability to predict - 'the propensity to consume offences'. Given: prisoners may commit no further crimes; any future crimes committed may be independent of the previous crime type; differences in prisoners future crime rates; and differences in future crime rates over time, accurate prediction is unlikely. Secondly incapacitation may be ineffective if imprisonment causes 'replacement'. For example D.F. GREENBERG (1975) states that imprisonment of a supplier in the illegal goods market will have no incapacitative effect: market demand will attract new entrants: "Economic law is not suppressed by legislated law", A.A. ALCHAIN (1972). It is concluded therefore that incapacitation effects should be computed for a range of likely future offence levels.

3.7. RECORDING EFFECT

As should already be apparent the data used in econometric studies is rarely equivalent to the concepts used in theory. This is particularly true in the case of the crime rate. In theory O is the actual level of offences, O_a . The measurable aggregate proxy of O_a is the recorded level of offences, O_r . In practice it must be assumed that O_a is accurately represented by O_r . O_a need not necessarily equal O_r , but it must be assumed that at any point in time any

differences in measuring O_r are random over jurisdictions, and over time O_a and O_r are directly proportional to one another. This assumption may be invalid if a 'recording effect' operates.

This effect represents all the processes which may be believed to generate changes in O_r independently of O_a . These processes may be split in two. First, the majority of crimes are reported by the public. So for example: the introduction of the 999 telephone system; increases in insured property; lower public tolerance of crime; and increases in victims perceived effectiveness of the C.J.S., may cause more crimes to be reported independent of any changes in actual levels. Second, reported crime has subsequently either to be recorded or not. This data is compiled by the people who are consequently evaluated by it. As a result the statistical reliability of such data is unknown. There are incentives to reduce (increase) the level of recorded offence rates in order to manipulate C.J.S. policy: "data is collected during the operation of a system only with a view to using it to formulate and control the implementation of policy. Those on whom the policy is going to operate or who are going to be controlled during its implementation have an obvious incentive to supply information that will ensure that the system operates in a fashion conducive to their interest", B. HILTON (1981). On the other hand, changes in criminal law (changing the range and definition of crime), and increases in the efficiency of recording practices may independently lead to increases in the level of recorded crimes. However, whatever the underlying causes proponents of the 'recording effect' believe that all these processes may be adequately represented in theory by the assumption: increases in police activity lead to increases in the proportion of crimes recorded.⁹ Thus, whereas O_a is a function of p (*ceteris paribus*):

$$O_a = f(p \dots) ;$$

(5)

O_r is a function not only of p but also C (i.e. the cost of resources devoted to the C.J.S.):

$$O_r = f(p, C, \dots);$$

(59)

and given (56a):

$$\partial O_r / \partial C = \frac{\partial O_r}{\partial p} \cdot \frac{\partial p}{\partial C} + \frac{\partial O_r}{\partial C}$$

(59a)

where $\frac{\partial O_r}{\partial p} \cdot \frac{\partial p}{\partial C}$ is the 'deterrent effect' and $\partial O_r / \partial C$ is the 'recording effect'.

Obviously O_r cannot exceed O_a so beyond a given level of C

$$\frac{\partial O_r}{\partial C} < 0 ;$$

(60a)

i.e. O_r will accurately reflect O_a . However below this level of C :

$$\frac{\partial O_r}{\partial C} > 0 ;$$

(60b)

increases in the resources devoted to the C.J.S. leads to an increase in O_r . If the 'recording effect' predominates:

$$\frac{\partial O_r}{\partial C} = \frac{\partial O_r}{\partial p} \cdot \frac{\partial p}{\partial C} + \frac{\partial O_r}{\partial C} > 0 ;$$

(59b)

O_r will not accurately reflect O_a : O_r rises as O_a falls. And even where the 'recording effect' does not predominate O_r may still not accurately reflect O_a .

For example

$$\frac{\partial O_r}{\partial C} = 0 ;$$

(59c)

the deterrent and the recording effect may cancel each other out: O_r remains the same as O_a falls. Or:

$$0 > \frac{\partial O_r}{\partial C} > \frac{\partial O_a}{\partial C}$$

(61)

the 'true deterrent' effect is underestimated because of the recording effect: O_r falls at a slower rate than O_a .¹⁰ Thus when the recording effect is assumed to exist O_r is unlikely to accurately reflect O_a . However the extent to which the recording effect alters estimates of the 'true deterrent effect' is unknown: O_a is unknown. So again, the 'appropriate' relationship between O_a and O_r is of necessity based on a subjective choice.

Before reviewing the possible bases of this choice it is necessary to examine the potential effect of recording bias on econometric results. Where the recording effect is assumed to exist¹¹ differences in measuring recorded

offences may be non-random over jurisdictions so those which report a relatively high (low) proportion of crimes will tend to have a relatively low (high) computed clearance rate. Furthermore if actual and recorded offences are not directly proportional to one another over time decreasing clearance rates may be caused by increased police activity not crime. Accordingly relationships between recorded and actual offences should be tested to determine the relative deterrence and recording effects.

The actual extent to which any recording effects alter estimates of the 'true' deterrent effect is not likely to be known given that the 'true' crime rate is unknown. However inferences about the relative influence of the deterrent and recording effects can (and should) be made. On the basis of experimental and questionnaire studies appropriate proxies (e.g. 'proportion of serious crimes') may be introduced into the aggregate crime rate function to determine and separate the influence of deterrence and recording on the recorded level of crime. While complete accuracy in measuring these separate effects is not expected their incorporation provides a necessary control on the estimates and policy conclusions derived about the efficiency of C.J.S. practices. The alternative view, that no inferences can be made about the true crime rate from the recorded crime rate, offers no basis for policy conclusions at all.

3.8. SEVERITY EFFECTS

In Becker's theory O is directly related to f , but f is not directly related to O . However since the 'output' of the police (i.e. certainty of punishment) is expected to be determined by crime, as well as being a determining factor of crime, the same may hold for the 'output' of the penal system, severity of

punishment; i.e:

$$f = f(o.....)$$

(62)

Prison sentences, f , may be a function of the crime rate, O , for two opposing sets of reasons.

3.8.1. POSITIVE SEVERITY EFFECTS

There may be a positive relation between crime rates and punishment because, given discretion in sentencing sentencers who believe in the deterrent role of punishment may attempt to 'compensate for' increases in offences by increasing punishment levels. Further, increased punishment may lead to increased recidivism: i.e. "the possible existing deterrent effect of severity on the general crime rate may be hidden by a backlash effect of punishment on those punished", C.H. LOGAN (1972). Finally, the greater the certainty of punishment the lower the punishment level because of plea-bargaining¹² and notions of 'just' punishment levels.¹³

3.8.2. NEGATIVE SEVERITY EFFECTS

Even in the absence of deterrence, there may be a negative relation between crime rates and punishment. Short-run constraints may force sentencers to lower sentence levels when crime rates increase. Given successively higher crime rates causing crowded prison conditions, lower prison sentences and the greater use of fines probation and suspended sentences may result. Secondly higher crime rates may lead to lower punishment levels in order to "try to avoid alienating too large a portion of the population from the society by labelling them and their associates as deviant and thereby risking the

fundamental stability of the society": A. BLUMSTEIN and J. COHEN (1973). The stability of society therefore depends on the maintenance of a constant level of punishment: increases in crime rates may be 'compensated' by falls in punishment risk.

Acceptance of the above implies a direct relationship between f and O should be postulated to isolate the positive and negative effects of crime upon sentence length from the deterrent effect of sentence length upon crime. For example P. PASSEL (1975) proposed the testing of the positive severity effect by regressing punishment with crime rates "given the discretion built into the system at each level it is plausible that, other things being equal, more convicted murderers will be sentenced to death the higher the perceived murder rate".

Within a full 'macro' model incorporation of these effects implies an additional equation and identification restriction(s) - identifying (a) measurable factor(s) which effect(s) sentence length but not crime rates. Measures of prison capacity appear appropriate assuming that potential offenders are unaware of its effect on severity.¹⁴ However if the level of punishment is constant as A. BLUMSTEIN and J. COHEN (1973) propose, an alternative explanation of any negative association between crime rates and imprisonment risk arises: increases in crime 'cause' falls in imprisonment risk, crime deters punishment and not vice versa. This view cannot therefore be incorporated into the economic model of the C.J.S. Isolation of the other effects proposed is however necessary and sufficient to determine any evidence of deterrence - they do not imply that the deterrence hypothesis is invalid.

3.9. AGGREGATION BIAS

Since this study proposes the use of cross-section data it is necessary to outline this potential problem. D.F. GREENBERG, R.C. KESSLER and C.H. LOGAN (1981) note that aggregation may lead to spurious correlation – increased crime in one area may be related to lower punishment risk in another. They thus proposed the use of city as opposed to US state data. Other solutions have included: rural-urban split, R.A. CARR-HILL and N. STERN (1979) and omission of randomly selected areas to test if deletion 'substantially' effects the co-efficients of the remaining data, W. VANDAELE (1978). It is concluded that such tests for aggregation bias should be imposed in this study.

3.10. CONCLUSION

The purpose of this chapter has been to provide an overview of econometric research of the C.J.S. Stress has been placed on the problems that arise as a result of (necessarily) founding such research on the economic theory of crime and punishment. The reason being that the results and policy implications derived cannot be judged useful unless these problems are outlined – such research must be seen to account for all the criticism levelled at it. While conclusions as to its worth are subjective the following judgements are offered. At worst, such research provides a coherent and consistent framework within which future debate and analysis of the efficiency of C.J.S. practices can take place. At best, it provides a substantive foundation for present policy decisions by allowing relatively accurate predictions to be made about the response of (potential) offenders to changes in C.J.S. policy. However given the (above) problems of adopting the economic approach it is fair to assume that, at present, the actual results obtained from empirical

research lie somewhat nearer the former end of this spectrum: "the fact that there are important limitations of the data and difficult methodological issues yet to be resolved should caution the reader against forming policy conclusions from any point estimate even if it passes 'conventional' tests of significance", K.I. WOLPIN (1978).

CHAPTER 4

SCOTTISH CRIMINAL JUSTICE SYSTEM: APPLIED MODEL

4.1. Introduction

Chapter Four provides an outline of the applied model subsequently used to test for the existence of deterrent effects across the Scottish Criminal Justice System over the period of 1970 to 1978.

Whereas the previous chapter indicated the general problems involved in modelling the Criminal Justice System, this Chapter concentrates on the specific problems encountered in modelling the Scottish system; the constraints placed upon the model by the general problems are however noted throughout. Emphasis is therefore placed upon the variables used, their consequent transformation in light of the local government organisational changes that occurred in 1975, and finally the implications which may be drawn (for modelling the Scottish system) from the apparent changes in each variable. While, at this point, such changes are not explicitly related to one another, it is concluded that the estimation and interpretation of the applied model should account for: the apparent differences in Scottish system practices over different crime classes; the effects of the 1975 reorganisation; and the socio-economic differences across Scottish regions.

4.2. Scottish Criminal Justice System

Scottish and English criminal law and procedures are not comparable: The two systems remain separate and – a unique constitutional phenomenon within a unitary state – stand to this day in the same juridical relationship to one another as they do individually to the system of any foreign country'; REPORT OF THE ROYAL COMMISSION OF THE CONSTITUTION (1974).

Scottish police neither initiate nor conduct prosecutions; this is the job of the procurator fiscal.¹ Jury trials are less frequent: in Scotland the accused has no right 'to opt' for jury trial. Clear-up rates are not comparable: in Scotland the accused cannot ask for 'offences to be taken into consideration'. Sentences are different: there is no English equivalent to the 'not proven' sentence available in Scotland. Criminal statistics differ: in Scotland the classification of each offence, where possible, is based on the outcome of judicial proceedings, not on the initial classification by the police; 'crimes' in Scotland are not equivalent to 'indictable offences' in England; and age ranges start at 16 in Scotland as opposed to 17 in England. Finally, the changes in Scottish and English legislation affecting criminal statistics have not been equivalent. Thus, the Scottish Criminal Justice System should be modelled independently of its English counterpart.

As a result there has been no econometric analysis of the Scottish C.J.S. Previous studies have (necessarily) analysed only the English C.J.S: CARR-HILL and STERN (1979); PYLE (1982) and WOLPIN (1978). However, there would appear to be some relative advantages in undertaking a study of the Scottish C.J.S. In particular, with regard to the problems of relating offenders to crime types (Certainty and Severity Index, Chapter Three), legislative change and plea bargaining (Recording Effects, Chapter Three) and the underlying purpose of the C.J.S. (Chapter Two). These advantages are:

(a) a greater congruence between offences and sentences
since:

(i) each offence (where possible) is classified
according to trial outcome: "the initial

classification of each crime or offence is determined by the police according to the circumstances surrounding the event: where relevant this initial classification is amended later to take account of subsequent court proceedings. At the end of each year the number of crimes and offences recorded during this year is adjusted for those found not to have been a crime" SCOTTISH HOME AND HEALTH DEPARTMENT: CRIMINAL STATISTICS SCOTLAND (1981)

- (ii) offences cannot be 'taken into consideration':
 "the practice (in Scotland) is to include in one indictment or complaint all outstanding charges on which there is sufficient evidence to proceed, and there is no way in which one or more charges may be libelled and other offences taken into consideration. Any charge that rests on the admission of the accused alone is not included in the indictment or complaint"; SCOTTISH HOME AND HEALTH DEPARTMENT AND CROWN OFFICE (1975).

(b) relatively few legislative changes affecting criminal statistics: "there has been very little legislation affecting

criminal statistics in Scotland compared with England and Wales. There has been no important changes in classification (such as that brought about by the Theft Act 1968) or new sentences (such as the suspended sentence)", M WALKER (1981).

- (c) a theoretically distinct separation between the roles of police and prosecutor. In Scotland the police never prosecute. The rate of conviction/aquittal is not therefore directly dependent upon police actions. Thus this data is not compiled by the people who are consequently evaluated by it, thereby reducing the problem of recording effects. Furthermore, taken together with (a) ii above, it would appear that the incentive to 'plea-bargain' is lower in Scotland. Since the Scottish police force do not prosecute they cannot be evaluated by convictions as opposed to their English counterparts who do and are, and thus have an incentive to plea-bargain (by taking offences into consideration and lowering certain punishment). In practice fiscals do 'negotiate pleas' but: "by negotiating pleas the fiscal is aiming for the result which would have been achieved had the accused been found guilty on all the charges as originally libelled while avoiding what he regards as a time wasting costly exercise which may not always produce the just result" S.R. MOODY and J. TOMBS (1982).

(d) a theoretical similarity between the basis of Scottish criminal law and the economic 'social loss' model. In Scotland prosecutions are (nearly) always public. They are conducted with reference to the 'public interest': "in [Scottish] criminal law, emphasis is placed less upon the wrong done to the individual but rather upon the wrong done against the community as a whole, its peace, order and well being". SCOTTISH OFFICE (1981) The economic model also emphasizes this interest - it defines those conditions which minimize the social (i.e. communities) loss from crime.

Given these relative advantages it is now necessary to comment on the (independent) Scottish C.J.S. in more depth.

The period considered is 1970-78. The main changes affecting the Scottish C.J.S. over this period are:

(a) On 15th April 1971, Part III of the Social Work (Scotland) Act 1968 was brought into operation. A new system of Children's hearings replaced the former juvenile courts and the age at which a person ceased to be (legally) defined a child was reduced from 17 to 16. In addition, the new system dealt with persons aged over 16 (but not yet 18) who were already subject to a supervision requirement. These changes did not directly affect the recording of 'the incidence of crime' or 'the clear-up rate'. However, they

did remove the practical relevance of the age 17 as a division for the purposes of age-grouping. And it was noted that: 'a change in the nature of the arrangements made for dealing with children must, in itself, be likely to have an effect on the nature of child crime brought to the attention of the police (and thus recorded as crime) which does not reflect any real change in the incidence of juvenile delinquency'. SCOTTISH HOME AND HEALTH DEPARTMENT, CRIMINAL STATISTICS SCOTLAND 1971 (1971).

- (b) On 16th May 1975, the Local Government (Scotland) Act 1973 came into operation. This led to the following changes: a reduction in the number of police forces from 20 to 8; the introduction of standardized methods of recording offences; the replacement of existing Justice of the Peace Courts and Burgh (or Police) Courts by District Courts and the assumption by Procurator Fiscals of all prosecutions in these courts; and an increase in the maximum fine impossible in summary courts (other than the Sheriff Court) from £50 to £100. The major effect of these changes was a once and for all increase in the recorded level of crime. As a result of new, simplified and computerized recording arrangements: 'less serious or clear cut incidents of crime which previously went unrecorded in those areas employing cumbersome reporting systems is now recorded'. SCOTTISH HOME AND HEALTH

DEPARTMENT; CRIMINAL STATISTICS 1975 (1976).

The effects of these changes in modelling the Scottish C.J.S. are incorporated in the outline below of the model itself.

4.3. Model

The model of the Scottish C.J.S. proposed adopts the three attributes common to previous studies: aggregate functions, a simultaneous equation framework, and log- linear specification. The latter is used (to reiterate Chapter Three) because the deterrent effects of punishment are assumed not to be additive, and to determine the correspondence of results with Becker's initial theoretical predications.

The basis of the model comprises the three relationships previously outlined in Chapters One and Three, namely:

$$(a) \text{ The Crime Rate Function } O = f(p, f, u)$$

(5)

$$(b) \text{ The Certainty Function } p = f(o, c, \dots)$$

(56)

$$(c) \text{ The Expenditure Function } c = f(o, p, \dots)$$

(2)

In addition, to account for the (potential) problems outlined in Chapter Three of recording effects, differences in perceptions, and severity effects, three

other relationships are postulated:

(d) The Recording Effect $O_r = f(p, c, \dots)$

(59)

(e) Differences in perception

$$p_a = f(p \dots)$$

(57)

$$f_a = f(f \dots)$$

(58)

(f) The Severity Effect $f = f(O \dots)$

(62)

On the basis of the above the following log-linear relationships are specified:

i) BASIC MODEL

$$O_r = \alpha_1 p_1 + \alpha_2 p_2 + \alpha_3 F + \sum_{i=4}^n \alpha_i x_i^1 + \alpha_o + (\alpha'_o - \alpha_o) D + \epsilon_1$$

(a1)

$$p_1 = \beta_1 O_r + \beta_2 @g[e] + \sum_{i=3}^n \beta_i x_i^2 + \beta_o + \epsilon_2$$

(b1)

$$E = Y_1 O_r + - 1 + Y_2 P_1 + \sum_{i=3}^n Y_i X_i^3 + Y_c + \epsilon_3$$

(c1)

; which in turn are supplemented by:

ii) Recording effort

$$\begin{aligned} Or = & \alpha_1 p_1 + \alpha_2 p_2 + \alpha_3 F + \sum_{i=4}^n \alpha_i x_i^1 \\ & - (1+\alpha_1)(\delta_1 \rho_n + \delta_2 Ov + \epsilon_4) + \alpha_0 + (\alpha'_0 + \alpha_0)D + \epsilon_1 \end{aligned}$$

(d1)

iii) Differences in perceptions

$$P_i p^+ = \sum_{i=0}^{\infty} \phi_i P_i + -i \quad \sum_{i=0}^{\infty} \phi_i = 1$$

(e1)

$$P_2 p^+ = \sum_{i=0}^{\infty} \phi_i P_2 + -i \quad \sum_{i=0}^{\infty} \phi_i = 1$$

(e2)

$$F p^+ = \sum_{i=0}^{\infty} \phi_i F p^+ - i \quad \sum_{i=0}^{\infty} \phi_i = 1$$

(e3)

iv) Severity efforts

$$F = \eta_1 Or + \eta_2 U + \eta_0 + \epsilon_5$$

(f1)

Detailed discussion of each of these functions (a1 to f1) in terms of their relation to theoretical counterparts (a to f), required data specifications,² and indicative trends over the sample period (1970 to 1978), are outlined below.

4.3.1. CRIME RATE FUNCTION

$$O = f(p, f, u)$$

(5)

$$O_r = \alpha_1 p_1 + \alpha_2 p_2 + \alpha_3 F + \sum_{i=4}^n \alpha_i x_i^1 \\ + \alpha_0 + (\alpha'_0 - \alpha_0) D + \varepsilon_1$$

(a1)

While in theory the economic model of crime is implicitly applicable to all crime types, this study focuses on Scottish property crimes. These offences were chosen as the motivation for these types of crimes would appear, a priori, more likely to be pecuniarily based than say, murder, and thus the measurable proxies for 'opportunity cost' and 'potential gains' more readily available. Consequently:

Or =

Annual recorded crimes (class II and III) per capita per police area. Class II crimes are defined as: 'crimes against property with violence'; and Class III crimes are defined as: 'crimes against property

without violence'.

These classifications (Class II and III) are based on pre 1979 definitions; 1979 published data which is based on a revised crime coding cannot be transformed to these definitions and was therefore not included. Furthermore Or excludes 'juvenile crime' for the following reasons. First the change in arrangements made for dealing with children (as discussed above). Second the irrelevancy of the unemployment rate as an explanatory variable of juvenile crime; as indicated below this variable is subsequently used as a measurable proxy for the 'opportunity cost' of adult crime. Finally, as a result of regional reorganisation in 1975, the absence of juvenile crime data for the years 1975 and 1976: "Arrangements for juveniles from 1971 operated satisfactorily from the inception of the new arrangements until 1975. From 1975, however, following local authority and police reorganisation it became apparent that the information being received was incomplete and did not adequately represent the number of children dealt with [as a result] no national statistics on children dealt with or named are included in this volume." CRIMINAL SCOTTISH HOME AND HEALTH DEPARTMENT: "CRIMINAL STATISTICS, SCOTLAND 1975" (1976).

Changes in Or over 1970 - 1978 in terms of the separate (02 and 03) and combined (023) levels of class II and III offences are indicated at Appendix A Table 1A. As is apparent over 1970- 78 023 increased throughout all regions. This trend was replicated for both O3 and O2 (with the exceptions of Northern and Tayside). The relative rates of crime per capita across regions remained consistent. On average Strathclyde and Lothian experienced the highest levels

of all offences. Tayside was the next highest. Below Tayside, Central experienced higher rates of O2 and O3 than Fife whereas on average Grampian had lower levels of O2 and higher rates of O3 resulting in a level of O23 between Central and Fife. Dumfries and Northern experienced the lowest levels of all regions. In all cases except Strathclyde the proportion of O2 to O23 was always lower than fifty per cent.

The overall increase in O23 was presumably in part due to the 1975 reorganisation. As stated previously new standardized methods of recording were introduced. Table 2A provides an indication of the potential affect of this standardisation. In only two cases the annual average change in Or for 1970-74 was above 1974-75: Central (+2% overall) and Fife (+7% overall). Similarly the annual change in Or for 1975-78 was above 1974-75 for the same two cases: Central (+3% overall) and Fife (+ 3% O3 only). Since no amalgamation took place in these areas in 1975 either the affect of reorganisation upon Or was relatively minimal (and) or the recording of crimes was relatively more extensive in these areas over the whole period. In all other cases the increase in Or for 1974-75 was above that for 1970-74 (on average 15% overall) and 1975-78 (12%).

In specifying the probability of capture (P), it is initially assumed that, in line with the conclusions drawn in Chapter Three, current indexes of certainty (and as indicated below severity) are appropriate. Moreover as published statistics separate total apprehensions from subsequent detentions (P) should be represented by the combined probability of arrest (P1) and conviction (P2) where:

P1

Ratio of annual recorded crimes for which one or more persons were apprehended, cited, warned or traced to the number of annual recorded crimes by class of crime and police area.

P2

Ratio of the (weighted average) number of people convicted and sentenced for detention to the number of people proceeded against by police area and class of crime.

Changes in P1 over the sample period are indicated in Table 3A. Overall, with one exception (Northern) P1 fell for all crimes and regions during 1970-78, with in all cases the average clear-up rate for 02 being lower than for 03. In addition although not exactly reversed the relative ranking of P1 appears generally opposite to Or. Dumfries, Fife and Northern experienced the highest levels of P1 over all offences, Central and Grampian the next highest, and finally Tayside, Lothian and Strathclyde the lowest rates.

As in the case of a rise in Or falls in PI from 1974 may in part be due to reorganisation: "many of the crimes which were unrecorded prior to regionalisation were unsolved cases. When these were included in the [1975] recording system the number of crimes made known increased but the number of cases cleared up did not, consequently the detection rate fell". SCOTTISH HOME AND HEALTH DEPARTMENT: CRIMINAL STATISTICS SCOTLAND 1978 (1979). However while this may be the case for all crime classes the

effect upon P1 is not as clear cut. Contrary to expectations in three cases (Central, Grampian and Lothian) the general clear up rate remained stable or increased over 1974–75. Given, in these cases, that it is not expected that crimes cleared would rise at the same or greater rate than the number of crimes recorded either some of the offences recorded as a result of reorganisation were not “unsolvable” or the clear up rate for “solvable” crimes increased by a greater percentage than shown in Table 4A.

In all other cases P1 did fall. However without knowledge of the number of unsolved crimes recorded as a result of reorganisation it is not possible to determine if these falls in P₁ are due to this effect.³

With regards to P2. As stated above this variable is a weighted average. Although data concerning the number of people proceeded against whose cases are disposed of within the year are published by police area and type of crime, data concerning the number of people convicted and the number of convicted people sentenced for detention is only published on a national basis. As a result P₂ is derived as follows:

For any given police area I:

$$P_{2I} = \frac{\sum_{n=1}^6 opIn \cdot \frac{ocsn}{opsn} \cdot \frac{osisn}{ocsn}}{\sum_{n=1}^6 opIn \cdot \frac{ocsn}{opsn}}$$

where

n
= sub category class of crime

opln

= number of people proceeded against in area l
sub category class of crime n

opsn

= number of people convicted in Scotland for sub
category class of crime n

opsn

= number of people proceeded against in Scotland
for sub category class of crime n

osisn

= number of people convicted and sentenced to
imprisonment in Scotland for sub category class
of crime n.

The (six) published definitions of n, and their unpublished sub category definitions are outlined in Table 5A. Obviously, Class II type 20 crimes (i.e. where n = 3) fall outwith the definition of 'economically motivated offences'. However since the proportion of such crimes proceeded against is negligible, inclusion of this category is unlikely to bias results. For example, the annual average percentages of Class II type 20 crimes to all Class II crimes for each police area are: Central 0.08%, Dumfries and Galloway 0%, Fife 0.04%, Grampian 0.06%, Lothian and Borders 0%, Northern 0.09%, Strathclyde 0.13% and Tayside 0.07%. Clearly, however, it would be preferable to regress each n separately – the motivation, incentives and disincentives for each n may be significantly different – however this is not possible given that offence rates

are only published for Class II and Class III crimes.

The changes in P2 are illustrated by Table 6A. With one exception (Northern) P2 showed little change over 1970-78. However this masks the fact that over all regions P22 (i.e. the conviction rate for class II crimes) increased whilst P23 (conviction rate for class III crimes) decreased. However in all cases the average conviction rate was (as expected) higher for class II 'crimes with violence'.

Finally, between 1974-75 P2 fell: the highest fall occurred in Fife (-8%) the lowest in Central (-1%). Except for Dumfries this fall was less than the annual average per region over 1975- 77. Furthermore in all cases it was at least 10% less than the annual average regional fall over 1972-73. Again the degree to which reorganisation affected P2 is unknown given no information about the percentage of "less serious or clearcut incidents" proceeded against. But on the basis of the above the 1974-75 change does not appear relatively different.

As already indicated above, in specifying sentence length (f) it is assumed that current indices of severity are appropriate hence:

$$F_3 =$$

Ratio of the (weighted) total length of annual current sentenced for persons sentenced to detention to the weighted average number of people sentenced, by class of crime and police area.

Since data concerning sentence lengths is also only published on a national basis F_3 has to be derived in a similar manner to P_2 . So for any given police area I:

$$FI = \frac{\sum_{n=1}^6 \text{opln} \cdot \frac{\text{ocsn}}{\text{opsn}} \cdot \frac{\text{oslsn}}{\text{ocsn}} \cdot \text{wsisn}}{\sum_{n=1}^6 \text{opln} \cdot \frac{\text{ocsn}}{\text{opsn}} \cdot \frac{\text{oslsn}}{\text{ocsn}}}$$

where opln, ocsn, opsn, oslsn, are as above for P_2 and:

wsisn =

the national median current sentence length for
sub-category class of crime n.

Median sentence lengths are used because the distribution of average current sentence lengths is skewed to the right: mean sentence lengths are 'pulled up' by a relatively few high sentences so the majority of sentences fall below the mean.

Changes in F over 1970-78 are illustrated by tables 7A and 8A. Except for Northern F changed relatively little during 1970-78. However this masks two underlying trends. First F_2 (i.e. for Class II crimes) increased over 1970-78 (except again for Northern) whilst over all regions F_3 (Class III crimes) decreased. Second whilst F_3 decreased gradually over the whole period, F_2 increased over 1970-75 but fell (marginally less) over 1970-78. In all areas however the average levels of F_2 were higher than F_3 . In addition due to weighting the average values of F remained similar for all areas. However F_2 varied more: there was a 22% difference between the highest and lowest levels of F_2 but only a 6% difference for F_3 .

Finally, reorganisation involved a change in prosecutors. As a result sentencing practices may have altered: "On 16th May 1975 the Justice of the Peace Courts and Burgh Courts existing immediately before that date ceased to exist and were replaced by District Courts one for each of the new district and island areas within the meaning of the local Government (Scotland Act) 1973 ... Prior to 16th May 1975 prosecutions in Justice of the Peace Courts and Burgh Courts were undertaken locally by appointed justice of the peace fiscals and burgh prosecutors respectively; a similar arrangement by which prosecutions were undertaken by locally appointed district prosecutors existed for a year thereafter in some District Courts pending the assumption by Prosecutor Fiscals of all prosecutions in the courts" SCOTTISH HOME AND HEALTH DEPARTMENT, CRIMINAL STATISTICS SCOTLAND 1977 (1978).

If these changes did cause an alteration in sentencing it is more evident for F2 than F3 (Table 8A). Over 1974-75 F3 changed little (in five areas it remained constant) whereas for F2 four regions had increases of over 20% (Central, Dumfries, Grampian and Lothian), two areas had no change (Fife and Tayside) and Northern experienced a 15% fall. However none of these changes (except Northern) were sustained: over 1975-78 F2 fell throughout.

In determining control variables (i.e. X_i^1 in (a1)) it is assumed, to reiterate the conclusions derived in Chapter Three that tastes are constant and therefore that only differences in 'objective' circumstances need to be accounted for in the Crime Supply Function. The choice of 'objective' proxies available however is severely limited: in contrast to national statistics relatively few economic or social indications are published on an annual Scottish regional basis. Consequently the following 'control variables' had to be, rather than were

selectively, chosen:

U =

Annual unemployment rate per police area to measure the 'opportunity cost' of crime.

I =

Annual total net real personal income per capita per police area to measure the 'potential gains' from crime.⁴

With regards to U, the normal data source is the Department of Employment Gazette. However over 1970-74 unemployment rates were (obviously) not published on a 1975 regional basis. Two additional sources were used to obtain this information.

1 - In 1978 the Scottish Office completed a retrospective analysis of the new regions (SCOTTISH ECONOMIC BULLETIN, No 15, 1978) which included 1970-74 June unemployment rates. However the June unemployment rate is normally below the annual average unemployment rate so the following adjustments were undertaken. Each regions June unemployment rate was adjusted upwards by the percentage difference between the annual average unemployment rate and the June unemployment rate of the local employment office areas which fell within the region concerned.⁵ Table 9A illustrates these offices per region.

2 - These transformations were only necessary for 1970-72. From 1973

annual average unemployment rates for new regions were published in the Scottish Abstract of Statistics. This data also provided evidence of the suitability of the previous adjustments. Comparison of 1973/74 rates using 1 and 2 showed on average a difference of only 0.22 per centage points.

From 1975 U was derived directly from the Gazette. Table 10A illustrates the changes in U over the whole period. Over 1970-74 U fell in all areas except Central (+ 0.5) and Strathclyde (no change). Two opposing trends were evident: a rise in all areas except Northern over 1970-72 (on average + 1.34 per centage points) followed in most cases by a larger percentage fall (on average -2.11 per centage points). Over 1974-78 unemployment rose continually. For all areas except Northern the rise in U was greater over 1974-76 (+2.61 per centage points on average) than 1976-78 (+ 1.25 on average). As a result over the whole period unemployment increased in all areas.

Relative rates remained generally consistent. Due to the North Sea oil related developments the lowest rate of U occurred in Grampian. On average the second and third lowest rates were in Lothian and Central. Over 1970 - 78 Dumfries and Galloway experienced the fourth highest average level. However during this period Dumfries' relative position changed. It had the fourth lowest average rates 1970-74 but the second highest 1975-78. Except for this change the next highest levels of U occurred in Tayside, Fife and Northern. Finally, given the contraction in heavy manufacturing Strathclyde (generally) suffered the highest levels of U.

Data for I, the proxy for potential gains, was obtained from the following

sources:

1. 1969/70-71/72 SURVEY OF PERSONAL INCOMES: net income totals by old Scottish counties. This was transformed to a new region basis as shown in the first two columns of Table 11A.
2. 1971/72-74/75 SCOTTISH ABSTRACT OF STATISTICS: net income totals by planning region. These totals, where necessary, were readjusted as given by the last three columns of Table 11A. Readjustments were derived by weighting planning region income totals by the proportion of total employed in the relevant police authority.⁶
3. 1975/76-1978/79: INLAND REVENUE STATISTICS (1975) and Survey of Personal Incomes (1976-1979): net total incomes by new Scottish regions.
4. 1970-78 CENTRAL STATISTICAL OFFICE ANNUAL ABSTRACT OF STATISTICS : annual average retail price index for the United Kingdom adjusted to 1970 = 100. This index is used since no separate Scottish index was available.

Since all data except (4) is given by tax year it had to be proportionally readjusted: 9/12 of any tax year being allocated to the reference calendar year, 3/12 to the next year.

The changes in I over 1970-78 are illustrated by Table 12A. The following

trends were evident. Firstly over 1970-74, except for Dumfries and Galloway (-7%) I rose by an average 11%. Over 1974-78, except for Fife (-10%) and marginally Strathclyde (-0.5%), I rose again, on average by 8%. Thus for the whole period I rose in all areas, on average by 13%. Secondly, comparison of 1970-74 average levels with 1974-78 indicated that in all cases except Central⁷ the annual average net income per capita was higher over 1974- 78 than 1970-74. Excepting Central then the overall trend in I was one of continued rise. Finally relative income levels amongst regions remained broadly stable: Lothian, Tayside, and Central consistently experienced the highest average levels per capita; Strathclyde, Fife⁸ and Grampian the next highest, and Dumfries and Northern the lowest.

Finally to account for the impact upon recorded crime rates of the implementation of the local Government (Scotland) Act in 1975 a dummy variable D is introduced into the Crime Rate function where:

D +

dummy set equal to zero for the years 1970-1974
and one for the years 1975-1978.

However, as indicated in Chapter Five, alternative dummy variables are subsequently used to account for the possibility of any aggregation bias.

4.3.2. CERTAINTY FUNCTION

$$P = f(O, c)$$

(56)

$$P1 = \beta_2 Or + \beta_2 E + \sum_{i=3}^n \beta_i X_i^2 + \beta_0 + \epsilon_2$$

(b1)

In theory, the probability of capture is a function of the actual level of crime, and the resources devoted to maintaining arrest rates given this crime rate. (56). To model this relationship it is therefore necessary to introduce Or , and a measure of resource costs, into the certainty function (b1). The measure used is:

$E =$

Actual annual per capita real police expenditure
per police area.

Clearly however, to reiterate the conclusions drawn in Chapter Three, aggregate expenditure is a poor proxy for the resources used to 'produce' $P1$. Police expenditure may not reflect other C.J.S. resources affecting the certainty function (e.g. differences in procurator fiscal practices). Arrests are subject to the discretion of individual police forces via the allocation of their resources to other crimes and activities, and (any) differences in recording practices. Finally the separate contributions of labour and capital are not isolated. Thus it would be preferable to disaggregate expenditure by crime and resources utilised. However, as also noted in Chapter Three, lack of data constrains the use of any alternative formulation: over 1970 to 1978 Her Majesty's Chief Inspector of Constabulary for Scotland Annual Reports published expenditure levels for regional force as an aggregate basis only. In light of the above, it is necessary to conclude therefore that the relationship between certainty and expenditure should be interpreted with particular caution.

E was derived by revising actual (as opposed to estimated) annual expenditure per financial year (ending April) per police area to real terms per calendar year. Table 13A illustrates changes in E over 1970-78. Regional levels of E increased throughout the whole period in all cases excepting Central (+ 19%) and Fife (+27%) by between 39% to 45%. In all cases the rate of change of E was greater over 1970-74 compared to 1974-78 excepting Dumfries (20% and 25% respectively). This reflects the joint influence of higher rates of inflation and a reduced commitment of government funding to regional councils in the latter period. Finally the relative levels of E remained comparatively stable, Central, Dumfries, Fife and Grampian recording on average the lowest levels of E (under £6 per head of population) Lothian, Northern, Strathclyde and Tayside receiving the highest levels of E (over £7 per head of population).

Finally in order to separately identify the Certainty function from the set of equations postulated it is necessary to introduce a control variable. As the formal economic theory does not provide a basis from which to chose such a variable, and given the relative lack of available Scottish regional data, the control variable used is:

$P_d =$

Population density (per square kilometre) per police area.

It is assumed that the higher P_d the lower P_1 as high density populations increase potential criminals anonymity and mobility: "the more densely populated a given locality, the greater the likelihood that anonymity will be

preserved by a law breaker, and hence the smaller the probability of his being apprehended"; N.Y. GREENWOOD AND W.T. WADYCK; (1973). In addition experimental studies (as outlined by B. LATANE and J. DARLEY (1970)) indicate that the larger the number of witnesses to a crime the less likely any individual will intervene or alert the police. Finally it may be argued that Pd reflects the ability of the police to respond to crime since the police force is a 'public good' and hence, *ceteris paribus*, the demands upon a force for all its services rises as Pd rises. However, it should be noted that Pd may also reflect differences in the 'crime-mix' between rural and urban areas. Urban areas tend to have both higher levels of Pd, and a higher proportion of violent to total offences; as the police typically devote more time to solving violent crimes, such crimes tend to have higher clear-up rates.

Changes in Pd are illustrated by Table 14A. In all cases except marginally Lothian (-0,75%), Pd increased continuously throughout 1970-78. The largest rise occurred in Tayside (+ 18%) the lowest in Dumfries (+ 1%). In addition the relative levels of Pd remained stable, however the range of Pd across regions was particularly marked - the lowest levels, 0.03 and 0.09 occurring in Northern and Dumfries respectively, with the highest 1.04 occurring in Fife.

4.3.3. Expenditure Function

$$C = f(O, P)$$

(2)

$$E = Y_1 Or_{t-1} + Y_2 P_1 + \sum_{i=3}^n Y_i X_i^3 + Y_c + \epsilon_3$$

(c1)

As already argued in Chapter Three E should be excluded from the crime rate function because it is only through the 'output' of the police, namely P_1 , that E is assumed to influence Or . In turn in order to identify this function, E is assumed to be predetermined (via budgetary cycles) by prior crime rates:

$$Or_{t-1} = \text{One year lagged annual recorded crimes per capita per police area.}$$

With regard to control variables two were chosen:

$$I_R = \text{Annual actual per capita real total rate income per police area.}$$

$$Pd = \text{population density (per square kilometre) per police area.}$$

I_R is assumed to represent the budget constraint upon E : Scottish police forces being under local as opposed to central government control. Furthermore since Or is expected to be positively correlated with I (in the crime Rate Function), it is assumed that not only do higher levels of I_R allow for higher levels of E , but also that higher levels of E will be demanded, i.e. the income elasticity of demand for police protection is expected to be positive

(assuming that expenditures on safeguarding property do not shift from public to private protection as income increases).

I_R is estimated by revising actual annual regional expenditure per financial year (ending April) to real terms per calendar year. Since 'actual' regional expenditure statistics were not published by cities, counties and large and small burghs over 1974/75, expenditure totals for this period were weighted by the annual average relative proportion of total 'actual' expenditure per region over 1973/74 and 1975/76. Changes in I_R are illustrated at Table I5A. In all cases I_R increased between 1970-78; the proportionate change in I_R being greater over the period 1970-74 compared to the period 1974-78 (and in the case of Fife, a decline occurred of 6% in this latter period). On average Northern, £115, experienced the highest levels, with other regions levels clustered around an average level of £95.50.

The second control variable chosen, P_d , is assumed to account for any dis/economies of scale in the cost of providing police services. As W.J. BAUMELL (1963) postulated, the cost of externalities is likely to rise more rapidly than the population since the probability of human interaction occurring over a unit of space increases as P_d increases.

4.3.4. Recording Effect

$$O_r = f(p, C, \dots)$$

(59)

$$O_r = \alpha_1 p_1 + \alpha_2 p_2 + \alpha_3 F + \sum_{i=4}^n \alpha_i X_i^1$$

$$- (1 + \alpha_1) [\delta_1 P_n + \delta_2 O_v + E_4] + \alpha_o + (\alpha'_o + \alpha_o) D + \varepsilon_1$$

(d1)

To account for the 'recording effects' discussed in Chapter Three it is assumed that in the original crime rate function (a1) that:

$$O_a = \alpha_1 p_{1a} + \alpha_2 p_2 \dots$$

(ai)

where

$$O_a =$$

Annual 'actual' crimes per capita per police area

$$P_{ia} +$$

Annual 'actual' detection rate by class of crime and police area.

, and that the ratio between the actual crime level and the recorded crime level is given, in log-linear form by:

$$O_a - O_r = \delta_1 p_n + \delta_2 O_v + \varepsilon_4$$

(di)

where

$$P_n =$$

Annual actual number of police personnel per

capita per police area.

$O_v =$

Ratio of annual recorded class II crimes to the total annual recorded class II and III crimes per police area.

so given that, again in log-linear form:

$$P_{ia} + O_a = P_1 + O_r$$

(dii)

P_{ia} and O_a may be substituted out of the original crime rate function (a1) to yield d1 above.

The two variables, P_n and O_v , are assumed to reflect the (potential) influence of recording effects on the following grounds. Firstly increases in P_n are expected to increase both the reporting of crime as : "more policemen are likely to increase the recording rate not by observing more crimes themselves and by making it easier or more worthwhile for a citizen to report them" R. THALER (1977). Secondly, it is expected that the more 'violent' the crime mix the more likely O_r is to accurately reflect O_a ; as R.F. SPARKS et al (1977) survey of London crime victims indicated: "notifying the police is mainly a function of the objective seriousness of the incident in commonsense terms".

Data for P_n was derived from Her Majesty's Chief Inspector of Constabulary for Scotland's Annual Reports. P_n includes all male and female regular police officers recorded per force as at 31st December of each year. Additional

employees (e.g. Traffic Wardens) were not included: public perceptions of the benefits of reporting crime are assumed to depend only the number of police officers available.

The changes in the number of police officers per 1000 capita are recorded in Table 16A. In all areas the number of police officers per capita increased over 1970-78. The largest rise occurred in Dumfries + 27% the lowest in Fife 1%.⁹ Comparison of average levels of P over 1970-74 and 1974-78 indicate that for all areas except Dumfries the increase in police officers per capita was higher in the former period. Finally the relative levels of police per capita remained stable. Strathclyde, Lothian, Tayside and Northern respectively employed the highest levels per capita (over two police officers per 1000 population 1970-1978). Grampian, Fife, Central and Dumfries police areas employed the lowest levels (below two police officers per 1000 population).

With regards to Ov, the ratio of Class II to total Class II and III crimes, Table 17A illustrates changes over 1970-78. Except in the case of Dumfries (+ 8%) and marginally Lothian (+ 1%) and Strathclyde (+ 2%) the regional levels of Ov declined over 1970-78. In addition, excepting Fife the absolute changes in Ov was greater over 1970-74 than 1975-78; the direction of change being negative for all areas except Dumfries (+ 28%) and Lothian (+ 3%) over 1970-74 and Northern (+ 8%) over 1975-78. However the relative levels of Ov remained stable. Central Belt areas recorded proportionally more violent crimes than elsewhere, and in all cases except Tayside¹⁰ the change in OV over 1974-75 ran counter to proceeding trends. Coupled with the relative stability of Ov after 1975 this indicates a change in recording practices and/or a change in the actual number of Class II crimes committed.

4.3.5. Differences in Perceptions

$$p_a = f(p, \dots)$$

(57)

$$f_a = f(f, \dots)$$

(58)

$$P1f+ = \sum_{i=0}^{\infty} \phi_i P1+-i \quad \sum_{i=0}^{\infty} \phi_i = 1$$

(e1)

$$P2P+ = \sum_{i=0}^{\infty} \phi_i P2+-i \quad \sum_{i=0}^{\infty} \phi_i = 1$$

(e2)

$$FP+ = \sum_{i=0}^{\infty} \phi_i FP+-i \quad \sum_{i=0}^{\infty} \phi_i = 1$$

(e3)

As there may be delays in the transmission of sanctions data and because deterrence implies past demonstrations of punishment effect the present conduct of potential offenders it is assumed that expectations (about expected punishment) are generated by a distributed lag on past values of recorded levels of certainty and punishment levels, i.e. $P1P+$, $P2P+$ and $FP+$ are the perceived detection rate, conviction rate and average sentence length in period t by class of crime and police area respectively. The restrictions placed on the lag structure (over $e1$ to $e3$ above) are described by ϕ .

Obviously the (simple) autoregressive models postulated assume that it is delays in the transmission of data that generate differences between actual and expected punishment. This implies that potential offenders are 'locked in by the past' and therefore ignore current conditions in making their predictions (except insofar as past demonstrations of punishment influence present expectations). It would be preferable, as outlined in Chapter Three, to postulate a set of alternative prior information sets for sub classes of the potential offender population. However given the theoretical basis of "cosmic utility analysis", this would (necessarily) involve the incorporation of alternative, and in more cases conflicting, criminological and non-criminological behaviour models.¹¹

4.3.6. The Severity Effect

$$f = f(o \dots)$$

(62)

$$F = \eta_1 Or + \eta_2 U + \eta_o + \epsilon_5$$

(f1)

In order to account for any (potential) severity effects it is assumed that an appropriate control variable is that of

U = prison utilization index

; since the existing prison capacity acts as a short-run constraint upon sentences it is expected that F will be negatively related to U in order to relieve the pressure on prison capacity.

However in determining the appropriate prison utilization ratio no theoretical basis is apparent – the effect of other sentences, the influence of regional capacities, and the time horizon involved all may, potentially, influence sentencers actions. As a result two alternatives are suggested: general capacity (PUG); and regional capacity (PUR).

PUG: General prison utilization ratio. In order to account for the influence upon present sentence rates of both previous years and the current number of offenders sentenced for all offences:

$$\text{PUGo,N} = \frac{\sum_{x=n-12}^{n=1} \text{So,x} + \text{So,}}{\text{Po, n}}$$

$$0 = 1,2$$

$$n = 1970 \dots 1978$$

$$x = 1958 \dots 1978$$

where PUGo,n = general prison utilization for all offences of type O in year n.

So, x = number of offences of type O sentenced in year x with median sentence length still current in year n

So, n = number of offence type O sentenced in year n

Po, n = total prison places for all offences of type O in current year n.

The type of offences which were matched to Class II and Class III crimes were related to the court in which they were proceeded against: "in Scotland there

are three criminal counts: these are the High Court of Justiciary, the Sheriff Court and the District (or summary) court. Broadly speaking the High Court deals with the more serious crimes, the Sheriff Courts with the less serious offences, and the District courts with minor offences". SCOTTISH OFFICE (1981). Accordingly crimes proceeded against in the High Court of Justiciary and Sheriff Courts were matched to Class II offences and those proceeded against in the District or Summary Courts were matched to Class III offences. The Scottish prisons which predominantly held offenders in these categories are listed in Table 18A.

It is apparent, from Table 19A, that over 1970-78 although the prison places available for offenders sentenced for serious crimes declined (PU2G increased by 46%), there was no overall constraint upon availability (the average level of PU2G being 0.78). In contrast, the average level of prison utilization for less serious offences was 1.059 – on average there were insufficient prison places available in prisons designated to hold offenders convicted for all 'less serious' crimes, despite increases in prison places (+32.5%) and a resultant decline in PU3G of 37% over 1970-78. However added together the combined effect of these two trends was marginal: the general prison utilization for all crimes fell by 3% over 1970-78, with the average level of utilization being 0.89.

PUR: Region prison utilization ratio. In order to capture the potential effect of present regional prison place availability upon current sentences across each region:

$$PUR_a = \frac{DPP_a}{PP_a} \quad a = 1 \dots 8$$

PUR_a = Annual regional prison utilization ratio for police area a, prisons and other offender institutions.

DPP_a = average annual daily prison population for all classes of offences in police area a prisons and other offender institutions.

PP_a = average annual prison places available in police area a, prisons and other offender institutions for all classes of offences.

The institutions appropriate to each police area are outlined in Table 20A; prisons for general as opposed to local use had places allocated to each region according to that regions relative proportion of convictions. Changes in PUR_a are illustrated in Table 21A. It is apparent that in all cases except Dumfries (0.68) the average level of PUR lies above 1.0. The apparent inconsistency between these levels and PUG results from two effects. Firstly PUR includes prison inmates awaiting trial, and secondly, PUG is calculated on the assumption that the probability of an offender being imprisoned is equal over all months in the year; in contrast PUR reflects the influence of seasonal fluctuations in sentencing.

Despite these differences, PUR does illustrate relative differences in regional prison capacity ratios – on average the highest levels of PUR occurred in Lothian, Northern and Strathclyde (1.38, 1.33, and 1.25 respectively) whereas the rest of the regions, except Dumfries, all experienced lower levels approximately equal to 1.0. Finally, the relative changes in PUR across regions followed no consistent pattern. Over the whole period PUR decreased in five regions, the largest fall in Lothian (-34%) while in the other areas, namely

Dumfries, Northern and Tayside, PUR increased. Similarly changes over 1970-74 and 1974-78 were apparently unrelated: in only one area, Strathclyde, did PUR change in the same manner over the two periods (decreasing by -19% and -4.5% respectively).

4.4. Conclusion

It is apparent from the preceeding data analysis that for Scotland as a whole, over the period of 1970 to 1978, class II and II crime rates rose (Class III proportionally more), and correspondingly, detection rates fell. The response of the C.J.S. to these (presumably) related trends differed over classes: both conviction and sentence rates rose for Class II crimes whereas they both fell in the case of Class III offences; constraints upon Class III prison places, as opposed to the apparent Class II availability may offer a partial explanation. In conjunction (and possibly in response to the rise in crime levels) expenditure per force, and the number of police officers employed, also rose throughout the period. Finally the identified proxy for gains, real income, rose throughout, whereas that for opportunity cost, unemployment, only progressively increased after 1974.

It is also clear that the reorganisation of local government in 1975 may be regarded as a 'cut-off' point between the preceeding and later time periods. While the full implications of this change upon model structures are analysed in the next chapter, the disproportionate rise in offence rates over 1974 to 1975, and the reduction in the rates of increase in rateable income, expenditure, and police numbers, all suggest that the apparent increases in recorded (and possibly actual) crime levels, and the ability of the C.J.S. to respond to these increases, may have altered after reorganisation.

Finally, it is evident that there are distinct regional differences across Scotland, in terms of both the levels of crime experienced, and attendant levels of C.J.S. resources and socio-economic conditions. In broad terms, the highest levels of crime, police per capita, expenditure, both income levels, prison regional capacities, and the lowest levels of detection occur in the two urban groupings of Lothian and Strathclyde, and Grampian and Tayside, whereas the lowest levels of crime, etc. occur in the two rural groupings of Central and Fife, and Northern and Dumfries.

In conclusion therefore, the estimation and analysis of the C.J.S. model outlined requires the incorporation of the above, namely, differences across classes, the effects of reorganisation, and apparent regional variations.

CHAPTER 5

MODEL RESULTS AND ANALYSIS

5.1. Introduction

The purpose of Chapter Five is to provide an overview and analysis of the estimations obtained using the model of the Scottish Criminal Justice System developed in the previous Chapter. A staged analysis is adopted whereby estimations for the whole of Scotland, as well as both crime classes, are contrasted with results using separate classes and regions. It is necessary however, in order to place this analysis in context, to outline the approach to, and constraints upon, model specification and estimation procedures.

The approach adopted, as implied by Chapter Four, is to combine all a priori information available, develop a general decision framework, and then undertake estimation. While this would suggest sequential testing procedures (either from the most 'general' model, or alternatively 'restricted' model versions outlined) there are obvious problems in the use of such procedures. Firstly there is no apparent natural ordering of hypotheses (particularly in the case of the crime supply function), some of the models are non-nested (for example aggregate functions compared to Class II functions) and thirdly some of the proxies postulated are clearly poor approximations to ideal conceptions (for example, expenditure). Finally, in light of the results outlined, there would appear to be limited value in undertaking formal exhaustive test procedures.

Paramount constraints are data quantity and quality. The use of pooled data, and thus cross-section time series analysis, is dictated by the relatively small

annual sample size of eight police force regions (interpretation is assumed to be that of a time series of cross sections in line with the 'short-term' policy implications inherent in the economic approach - see Chapter Three). Moreover while elimination of the structural change caused by reorganisation would be preferable, the redefinition of offences after 1978, and the limited data set per region over 1970 to 1974, and 1976 to 1978, again results in the intractable problem of degrees of freedom given the general decision framework adopted. Finally the lack of juvenile and disaggregated expenditure data, as well as reorganisation obviously place severe constraints upon data quality, and therefore the robustness of the results obtained.

From the above it is clear that the type and depth of analysis is limited by the data set available and the general framework adopted. As a result emphasis is placed upon the changes upon the general framework which may be inferred from the initial data analysis in Chapter Four (i.e. reorganisation, and differences over crime types and regions), and where possible, changes where specific results conflict with a priori theory. It is assumed that these changes require more examination whereas results which conform with theory do not, given the previous theoretical analysis and the conformity of previous studies results with this analysis.

Finally, it is concluded that on balance the results obtained from the analysis outlined do not provide a sufficient basis from which to derive policy conclusions concerning the actual operation of the Scottish system.

5.2. Approach

Initial estimates are derived from analysing the functions outlined in Chapter Four (i.e. (a) to (f)) across both crime classes (aggregated crime rates) and all Scottish police authorities (aggregate regional structure). Three different model structures are used:

Model One

Crime Rate function with and without recording effects

Certainty function.

Model Two

Crime Rate function with and without recording effects

Certainty function.

Expenditure function.

Model Three

Crime Rate function with and without recording effects

Certainty function

Expenditure function

Severity function using both prison indexes.

However before examining the results obtained from these model structures it is necessary to outline the approach taken to aggregation.

While data constraints dictate the use of pooled data, the choice of testing is not clear cut since observations over the period of 1970 to 1978 form three interdependent groups: offences (two crime classes); regional (eight police authorities) and structured (pre and post local Government (Scotland) Act, 1975). Discussed below are the significance of these differences and the procedural steps taken to account for them within the general model structures.

5.2.1. Crime Rates

A priori Class II crimes (crimes against property with violence) and Class III crimes (crimes against property without violence) may be aggregated. Although definitionally precise the actual category of crime recorded depends on a series of factors which may cloud the difference between classes.

Firstly, the category of crime recorded depends on a police officer's judgement of the circumstances reported to him or her. Variations are inevitable: "there are no hard and fast rules to cover classification of every criminal act and to this extent the classification depends on the subjective judgement of the investigating police officers". SCOTTISH HOME AND HEALTH DEPARTMENT, SCOTTISH CRIMINAL STATISTICS 1977 (1978).

Secondly, this classification may be altered by the procurator fiscal. Again variations, across fiscals and regional offices, result. For example, as indicated by the quotes of various fiscals to S.R. MOODY & J. TOMBS (1982), differences between fiscals: "who knows what is standard ... we do not really have clear

guidance on this it should be more or less the same in all offices but some people are working with a different understanding of the concept of seriousness from others." In addition, differences between offices; "there are bound to be regional variations, as in the Western Isles context behaviour A is really serious, behaviour B is not serious. In Edinburgh, it is the other way round".

Finally, classification may be altered during court proceedings. The actual difference between Class II and III crimes is therefore vague. In contrast the effect of regional differences and structural change may be more clear.

5.2.2. Regional Differences

Scottish regions are distinct: the initial data analysis presented in the previous chapter revealed differences on the basis of all variables used. For example, the mean per capita value of Class II and III crimes ranged from 0.019 (Dumfries and Galloway) to 0.049 (Strathclyde); police personnel from 0.0017 (Northern) to 0.0024 (Strathclyde) and real income, at 1970 price levels, from £410.73 (Northern) to £522.19 (Lothian and Borders).

In addition since police forces in Scotland are under local and not central government control, police strategies are determined by each local Chief Constable. Their response is determined by regional conditions and the resources they command; both these factors differ over forces. This may be illustrated by the case of Strathclyde. Historically it has experienced both the highest per capita crime rates and police personnel. Concurrently the region established the first Scottish regional crime squad, flying squad, support unit, and fully computerized monitoring system.

5.2.3. Structural Differences

On the 16th May 1973 local government areas in Scotland were reorganised. A priori all endogenous variables used in the model structures outlined may be affected.

Crime Rates

Reorganisation reduced the number of Scottish police forces from twenty to eight and resulted in new, standardized methods of recording crime being introduced. As previously stated this is likely to have led to less serious or clear cut crimes being recorded causing a (potential): "increase in the statistics of crime when compared with previous years." SCOTTISH HOME AND HEALTH DEPARTMENT, SCOTTISH CRIMINAL STATISTICS 1975 (1976).

Certainty Rates

As a result of less 'clear-cut crimes' being recorded after 1974: "many of the crimes which were unrecorded prior to regionalisation were unsolved cases". SCOTTISH HOME AND HEALTH DEPARTMENT, SCOTTISH CRIMINAL STATISTICS 1979 (1981). So if after 1974 the rise in recorded crime led directly to a fall in the number of crimes cleared up, *ceteris paribus*, detection rates would fall.

Police Expenditure

1975 marked the beginning of central government's attempts to reduce Scottish local government expenditure. Since this time central government grants as a percentage of total local expenditure have continually fallen. In 1975 Central Government planned to reduce the new Scottish authorities total

expenditure by 16.4% between 1975 and 1982 using: "the leverage implicit in the grant system to enforce these spending cuts"; D. HEALD (1982). Police expenditure did not remain unaffected – in 1975 real expenditure per capita on regional forces fell on average by -0.48%, and while it rose again thereafter the annual average increase was reduced to 2.99% over 1975 to 1978 compared with 4.75% over 1970 – 1974.

Sentence Rates

Prior to 1975 the fiscal service presented cases in the Sheriff Court only: local authority solicitors dealt with all the business of burgh justices of the peace and stipendary courts. After 1975 Procurator Fiscals undertook all prosecutions in these courts. This may have led to a change in the allocation of cases to different courts and thus the sentences imposed. As MOODY and TOMBS (1982) noted Procurator Fiscals tended to be critical of the lay judiciary on four counts: lack of legal knowledge; absence of professional training; lack of court experience; and finally (as a result) 'too lenient sentences'. Prior to 1975 such attitudes could not practically impose upon case allocation, but after 1975: "our examination of these attitudes adopted suggests that such evaluations are critical to the distribution of business between summary courts." For example they quote a Procurator Fiscal who stated: "we might feel that there are evidential complexities or something which they might not be able to cope with terribly well and we would want a Sheriff to deal with this although on the face of the actual offence it is District Court material."

In contrast to crime classes, therefore, it is apparent from the above that on aggregate, regional differences and structural change may have a significant

affect on model structures. Initial analysis confirmed this: in the majority of cases (see Table B1) F-tests for each function rejected the hypothesis that pooled regional co-efficients were the same. Accordingly dummy variables were introduced to (potentially) account for these significant differences across regions. Initially two types of dummy variables were used.

Regional (DR)

To account for potential differences in the regional levels of endogenous variables over the WHOLE sample period, dummies for seven regions were introduced into pooled equations (for each function) with the 'reference' region being Northern. The value of each regional dummy being one over its own sample for 1970 to 1978, and zero over all other sample points.

Regional-Structural (DRX)

To account for potential differences in the regional levels of the endogenous variables as a RESULT of structural change¹ dummy variables for seven regions FROM 1975 were introduced, again with Northern as the reference region. The value of each regional dummy being one over its own sample for 1975-1978, and zero over all other sample points.

To test the hypothesis of equality of all aggregated regional co-efficients using both these types of dummies, F tests, similar to the above, were carried out on each function. Results of this co-variance analysis are presented at Table B2. It is apparent that across all functions the introduction of one of the above dummy variables allows estimation on an aggregate (i.e. crime and regional) basis. For three functions the hypothesis is rejected for one of the

dummies: DRX in the case of the crime rate without recording effects and the expenditure rate, and DR in the case of the certainty rate. However in both other cases – the crime rate with recording effects and the severity rate – the hypothesis of equality of all co-efficients is not rejected for either set of dummies.

While the above indicates (except in the case of the certainty function) that regional differences over the whole period, rather than structural change after 1975 predominate, since initial results (should) provide an instrumental basis for further analysis and thus explanation, the choice of the 'appropriate' dummy was left open; estimation proceeded for all functions where the hypothesis of equality was not rejected.

This openendedness however leads to various 'dummy combinations'; across models one to three and it is therefore necessary to estimate a series of difference model types. These model types are presented at Table B3.

For example in the case of model one three model types are estimated:

<u>Functions</u>	<u>Dummy Variables</u>
(i) Model One A	
Crime rate without recording effects	DR
Certainty rate	DR
(ii) Model One B	
Crime rate with recording effects	DR
Certainty rate	DRX
(iii) Model One C	
Crime rate with recording effects	DRX
Certainty rate	DRX

Thus to reiterate, initial results are based on the following:

- aggregated crime classes and regions:
- four functions: and
- three model structures, and consequent 'dummy model types';

5.3. Initial Results

All model structures were subject to two stage least squares regression analysis. Across these structures, type A (regional dummies for all functions except certainty) provided the most relatively consistent and statistically significant results. Detailed discussion of this model type, therefore, provides a basis for comparing both general trends across the other model structures and further analysis. Type A model structure co-efficient results are presented at Table One; analysis of these results is given below.

5.3.1. Crime Rate Function

Across the model structures (in Table One) both probability co-efficients tend to be consistent with theoretical prediction; both are generally significant with (negative) elasticity values of less than one. However contrary to BECHER's original optimum conditions (Chapter One) and previous studies results (Chapter Three) the elasticity of certainty (ranging from -0.14 to -0.32) is less than the elasticity of conviction conditional on capture (-0.44 to -0.52), indicating that offences, and therefore those who commit offences, are more responsive to an increase in the probability of imprisonment conditional upon capture than an equal increase in the probability of capture itself. Moreover sentence lengths co-efficients while significant are positive (+0.62 to +1.12) implying that reductions in punishment levels would result in a fall in offences

greater to than those resulting for any equivalent proportionate increase in the probabilities of capture.

While it may be tempting to draw certain policy conclusions from these results, on the basis that a redistribution of resources away from the prison service towards the police force would, *ceteris paribus*, reduce offence levels for the crime classes analysed, such conclusions should be tempered by the previous analysis of the affects of crime rates upon sentence rates. A priori, this affect may be ambiguous: the output of the penal system namely the severity of punishment, may be determined BY crime (through sentences belief in deterrence and receividism affects – see Chapter Three) as well as being a determining factor OF crime. Of the model structures estimated only Model Three attempts to isolate these two effects, but even in this case there is no evidence of an isolated deterrent effect (the Model Three Crime Rate Function elasticates values with respect to sentence lengths are +0.68 and +1.12 respectively). It is more tempting therefore to conclude, within the context of the theorectical analysis of this study, that a positive severity effect would appear to predominate.

TABLE ONE : CO-EFFICIENT VALUES

MODELS ONE TO THREE TYPE A RESULTS

MODEL ONE (A)

LO23 = -7.74 C -0.14 LP1 -0.44 LP3 +0.79 LS +0.47 LIN +0.38 LU
 (-12.96)** (-0.89) (-4.72)** (3.94)** (4.64)** (6.33)

 $R^2 = 0.93$

LP1 = -4.85 C -0.89 LO +0.40 LEP +0.04 LPD
 (-9.36)** (-9.37)** (3.19)** (2.09)*

 $R^2 = 0.72$

MODEL TWO (A)

LO23 = -7.54 C -0.22 LP1 -0.52 LP3 +0.62 LS +0.40 LIN +0.31 LU
 (13.30)** (-1.79)* (-5.57)** (3.47)** (4.04)** (5.66)**

 $R^2 = 0.92$

LP1 = -5.40 C -0.98 LO23 +0.51 LEP +0.06 LPD
 (-8.13)** (-8.22)** (3.11)** (2.24)**

 $R^2 = 0.70$

LEP = -0.09 C -0.05 LO23L -0.18 LP123 +0.90 LRI +0.67 LPD
 (0.08) (0.08) (-2.56)** (6.67)** (2.98)**

 $R^2 = 0.88$

MODEL THREE (A) LPUG

LO23 = -7.59 C -0.32 LP1 -0.49 LP3 +0.68 LS +0.42 LIN +0.29 LU
 (-12.91)** (-2.44)** (-5.08)** (3.28)** (4.04)** (5.09)**

 $R^2 = 0.93$

LP1 = -5.10C -0.93 LO +0.45 LEP +0.05 LPD
 (-7.56)** (-7.64)** (2.75)** (1.89)*

 $R^2 = 0.68$

LEP = -0.11C -0.005 LO23L -0.27 LP1 +0.93 LRI +0.74 LPD
 (-0.09) (-0.06) (-2.59)** (6.33)** (2.98)**

 $R^2 = 0.87$

LS = -0.80 +0.02 LO -0.22 LPUG
 (-2.25)** (0.19) (-1.10)

 $R^2 = 0.1$
 $t_{0.01} = **$
 $t_{0.05} = *$

MODEL THREE (A) LPUR

$$\text{LO23} = -7.53 \text{ C} \quad -0.29 \text{ LP1} \quad -0.46 \text{ LP3} \quad +1.12 \text{ LS} \quad +0.48 \text{ LIN} \quad +0.31 \text{ LU} \\ (-11.49)** \quad (-1.97)** \quad (-4.26)** \quad (4.16)** \quad (4.07)** \quad (4.89)** \\ R^2 = 0.91$$

$$\text{LP1} = -5.05 \text{ C} \quad -0.92 \text{ LO} \quad +0.44 \text{ LEP} \quad +0.05 \text{ LPD} \\ (-7.57)** \quad (-7.65)** \quad (2.79)** \quad (1.85)* \\ R^2 = 0.68$$

$$\text{LEP} = -0.13 \text{ C} \quad -0.01 \text{ LO23L} \quad -0.28 \text{ LP1} \quad +0.94 \text{ LRI} \quad +0.74 \text{ LPD} \\ (0.10) \quad (-0.12) \quad (2.60)** \quad (6.30)** \quad (2.98)** \\ R^2 = 0.87$$

$$\text{LS} = -0.49 \text{ C} \quad +0.08 \text{ LO} \quad -0.06 \text{ LPUR} \\ (-2.40)* \quad (1.40)* \quad (-0.74) \\ R^2 = 0.01$$

$$\text{T0.00} = **$$

$$\text{T0.05} = *$$

Regression Subscripts

Subscript	Variable
LO23	Annual recorded crimes (class II and III) per capita per police area (Or)
LP1	Ratio of annual recorded crimes for which one or more persons were apprehended to number of annual recorded crimes per police area (P_1)
LP23	Ratio of number of people convicted and sentenced for detention to the number of people proceeded against (P_3)
L5	Ratio of total length of current sentences for persons sentenced to detention to the average number of people sentenced (F_3)
LIN	Annual total net real personal income per capita (I).
LU	Annual unemployment rate (U).
LEP	Actual annual per capita real police expenditure (E).
LPD	Population density per square kilometre (PD)
LO23L	One year lagged annual recorded crimes per capita (Or $+1$).
LRI	Annual actual per capita real total rate income (Ir)
LPUG	General prison utilisation ratio (PUG)
LPUR	Region prison utilisation ratio (PUR)

Note: Detailed analysis of each variable, by reference to the variable parenthesis (e.g. Or) is given at Chapter Four.

Control variables, income and unemployment, are consistent with initial expectations: both co-efficient values are significantly related to the crime rate (ranging from +0.46 to +0.48 and +0.29 and +0.38 respectively). Increases in the potential gains from crime (income) therefore appear to 'generate' greater increases in crime than an equivalent percentage rise in the opportunity cost of crime (unemployment). However in contrast to the generalised results of previous studies neither appear to exert a significantly greater affect than the deterrent variables analysed.

5.3.2. Certainty Rate Function

As indicated in Table One, co-efficient values for all Type A structures are significant and, excepting population density, consisted with theoretical expectations. Offence rates are negatively related to certainty; increases in the offence rate lead to near proportionate falls in the probability of capture (offence rate co-efficient values range from -0.89 to -0.98). Expenditure co-efficient values are positive and significant. Thus while a poor proxy for the resources devoted to the crime classes analysed, it would appear that an increase in the overall level of real expenditure devoted to all police resources resulted in an increase in police output (i.e. the probability of capture) for these classes. Unfortunately as already discussed in Chapter Four, the overall impact (expenditure co-efficient values range from +0.40 to +0.51) cannot be separated in terms of individual labour or capita inputs.

Finally, population densities are positively related to certainty, ranging in value from +0.05 to +0.06. While the result may be interpreted to reflect the influence of differing crime mixes across regions, it is more likely to be a result of economically depressed regions declining population levels higher

rates of crime and therefore lower probability of capture. In either case however this result is contrary to the initial expectation (outlined in Chapter Three) that higher population densities reduce the likelihood of capture.

5.3.3. Expenditure Rate Function

Over both models two and three, real expenditure per capita per police force is significantly but negatively related to the probability of apprehension (with a co-efficient value of between -0.27 and -0.28). This is counter-intuitive; in theory costs increase as the probability of conviction increases. Moreover an alternative theoretical explanation – that of a predominant recording effect – does not appear to hold either. The prediction that increases in certainty reflect reduced costs (i.e. lower costs reduce police resources increasing certainty by recorded offences falling proportionally more than crimes cleared up) is not consistent with the results that expenditure co-efficients are positively related to certainty (certainty function), while being unrelated to recorded past offence levels (expenditure function).

This latter result – that past offence levels appear to have no statistically discernible effect upon expenditure – is also counter to theoretical prediction. If it is assumed that previous crime rate levels are the relevant reference (since expenditure levels are planned at the beginning of the financial year in advance of annual actual crime levels), then as crime rates rise over time it would be predicted that additional resources would be needed in order to maintain a given level of apprehension. This relationship however is not apparent from the results obtained.

Finally, both exogenous variables, rateable income and population density, do

accord with theoretical prediction. Both co-efficient values are positively and significantly related to expenditure reflecting a positive income elasticity of demand for criminal justice services (co-efficient values of +0.93 and +0.94 respectively) with diseconomies of scale in the production of these services (+0.74 in both cases).

5.3.4. Severity Rate Function

As indicted in Table Two, both prison utilization indexes are statistically insignificant. In addition, for the general index function (PUG) no relationships are discernible, and while for the regional index (PUR) offence levels are positively related to sentences (+0.08 co-efficient value) the same relation holds for the crime rate function. It is apparent therefore that on its own, and within the initial model structures, the severity function provides no evidence of capacity constraints influencing sentence rates, nor any evidence of a separate deterrent effect; as indicated above a positive severity effect appears to predominate

5.4. Initial Conclusions

It is apparent that across the model types analysed the crime rate and certainty rate functions do provide limited evidence of deterrence but the expenditure and severity functions neither alter the above nor add any clear or predictable impact themselves. Moreover outline investigation of the other model types examined, using recording effects and regional structural dummies, further reduces the (a priori) implications which may be drawn from initial results. While police per capita and the proportion of violent offences are in most cases positively and significantly related to offence rates, suggesting the potential influence of recording effects, their introduction

reduces the statistical significance of the deterrence variables used.² In addition as initial variance analysis indicates the introduction of a regional structural break after 1974 appears to provide less consistent results in comparison to accounting for regional differences across the whole period.

Given the above, and the theoretical framework from which they are interpreted, results which are inconsistent with theoretical prediction (i.e. sentence lengths in the crime rate function, and probability of apprehension in the expenditure function) or insignificant (i.e. past offence levels in the expenditure function) necessitate further explanation. It is appropriate therefore given initial data constraints to determine whether an explanation is provided by using alternative model structures. Since initial results are based upon both aggregated crime rates and regional structure resultant alternatives are as follows:

- (a) though on the margin actual definitional differences between classes may be vague, on aggregate (as indicated in Chapter Four) there may be differences in the practices adopted to deal with them. Relaxing the assumption of aggregated crime rates therefore, results in disaggregating classes and analysing them separately for Scotland as a whole.
- (b) As already discussed regional and structural differences would appear to be significant. Relaxing the assumption of aggregated regional structure therefore allows analysis of (any) differences in practices and structural change amongst regions for aggregated crime rates.

- (c) Finally, relaxing both the above assumptions together allows analysis of any inter-regional differences over separate class types.

5.4.1. Disaggregated Crime Rates

The basis for estimation of Scottish disaggregated crime rate functions is equivalent to that upon which the initial findings derived from aggregate rate functions are based except that:

- offences are analysed separately, and not together by class type:
- and, the proportion of violent to non-violent offences is (necessarily) excluded as an explanatory variable.

Furthermore, since aggregate regional differences and structural change may still have a significant affect upon model structures, co-variance analysis similar to that for aggregated classes was undertaken for all functions across both class types. The results obtained from this analysis, and the resultant estimated model structures, are discussed below by crime class type.

5.4.2. Class II Crimes

Using the same F-tests as outlined at Table B1 the hypothesis of equality of all pooled regression co-efficients without dummies was rejected for each function (see Table B4). Inclusion of the two sets of dummy variables in each function provided the results shown in Table B5. As is apparent, across the majority of functions, there is only one set of dummies namely regional dummies (DR) where the hypothesis of equality of all pooled co-efficients with dummies is not rejected, although in the case of the severity function the

hypothesis was not rejected for either set of dummies and model three therefore has two types as given in Table B6. In the case of the crime rate function with inclusion of a recording effect the hypothesis was rejected for both sets of dummies. (For disaggregated crime classes this effect is assumed to be represented by police per capita per region only). Inclusion of the recording effect therefore prevents estimation of an aggregate Scottish class II crime rate function indicating instead a difference across regions for both recording practices and/or responses to Class II crimes and the necessity therefore to estimate disaggregated regional functions.

In contrast to the aggregate results outlined previously the estimates derived from Class II functions are relatively poor; the inferences which may be drawn across the two sets of results was therefore limited. As indicated in Table B7 the only significant and consistent relationship between endogenous variables holds for offence rates and the probability of certainty in the crime rate and certainty functions. However no statistically significant results are discernible between:

- offence rates and the probability of imprisonment and punishment levels;
- certainty rates and expenditure
- expenditure and the probability of capture
- severity and offence rates and prison utilization

Thus while the control variables of unemployment and income in the crime rate function, and rateable income and population density in the expenditure rate function, are all significant and positive and therefore consistent with a priori expectations it is difficult not to draw the overall conclusion that Class II

estimates provide little evidence of the initial theoretical predictions postulated. Whether this is a result of misspecification (possibly resulting from differences in the practices or constraints upon responding to Class II rates as implied by the broad trends discernible in the basic data as outlined in Chapter 4) remains open to question given the problems in formulating and estimating a model within the original theoretical framework and available data sources.

5.4.3. Class III Crimes

Adopting the same F-tests as those for Class II functions, the hypothesis of equality of all pooled regression co-efficients (without dummies) was rejected. Subsequent co-variance analysis of all aggregated functions, using both sets of dummies, provided the results given at Table B8. As indicated for both DR and DRX the hypothesis of equality was not rejected for any function except expenditure (where DRX was rejected). Resultant 'model types' are given at Table B9.

In comparison to Class II results, Class III estimates are relatively more consistent with initial theoretical predictions, and therefore do allow inferences to be drawn between these estimates and initial aggregate results. Across the model types estimated for Class III crimes the most consistent and statistically significant results were obtained for type C models (which, similar to the aggregate model type A, include regional dummies for all functions except certainty). Results for these model types are presented at Table Two. Interpretation, by function, is discussed below.

5.4.4. Crime Rate Function

As outlined in Table Two across all model structures there are no significantly inconsistent co-efficient values: deterrent co-efficients are negative and, with the exception of sentence rates in models two and three, significant throughout. Like the aggregated results reported in Table One, the elasticity values of significant deterrent variables tend to be opposite to theoretical prediction – the elasticity of capture (ranging from -0.25 to -0.31) being less than that of conviction (ranging from -0.35 to -1.01) and in the case of Model One, less than that of sentence lengths (-1.19). In comparison to aggregate results Class III estimates therefore indicate relatively little difference in the degree of responsiveness of changes in deterrent variables with the notable exception of severity rates. For in contrast to an apparent dominance of a positive severity affect over aggregated Class II and III crime types, disaggregated Class III severity estimates indicate either a deterrent effect (with a co-efficient value of -1.19 in Model One) or no apparent discernible influence at all (models two and three). As outlined previously (in Chapter Four) over the period studied Class III, as opposed to Class II crime rates, were subject to prison capacity constraints. As outlined in Table Two, Model three estimates do indicate a negative and significant effect upon prison sentences of increases in Class III offences (-0.18 for LPUG and -0.24 for LPUR). Accordingly in contrast to aggregate results, Class III sentence rates would appear to be subject to a negative severity effect; however, the corresponding deterrent effect, if any, remains unclear.³

The control variable results, in terms of directional influence and co-efficient values are similar to aggregated estimates; both are significant, and as expected positively related to crime rates, with the impact of changes in

TABLE TWO : CO-EFFICIENT VALUES
MODELS ONE TO THREE TYPE C RESULTS

MODEL ONE (C)

LO 3 =	-9.64C (-14.75)**	-0.25 LP13 (-1.43)*	-0.35 LP33 (-1.81)*	-1.19 LS3 (-2.67)**	+0.45 LIN (3.96)**	+0.21 (3.45)
	$R^2 = 0.85$					
LP13	-3.77 C (-6.59)**	-0.59 LO3 (-5.84)**	+0.26 LEP (2.23)*	-0.03 LPD (-1.71)*	$R^2 = 0.52$	

MODEL TWO (B/C)

LO 3 =	-9.62 C (-15.29)**	-0.31 LP13 (-2.22)*	-0.79 LP33 (-3.78)**	-0.16 LS3 (-0.33)	+0.45 LIN (4.08)**	+0.16 LU (3.04)**
	$R^2 = 0.89$					
LP13 =	-3.98 C (-5.86)**	-0.64 LO3 (-5.43)**	+0.26 LEP (1.83)*	-0.03 LPD (-1.50)*	$R^2 = 0.48$	
LEP =	-0.23 C (-0.19)	-0.004 LO3L (-0.05)	-0.34 LP13 (-3.27)**	+0.95 LRI (6.34)**	+0.73 LPD (2.58)**	$R^2 = 0.88$

MODEL THREE (B/C) LPUG

LO 3 =	-9.21 C (-14.81)	-0.33 LP13 (-2.31)*	-1.01 LP33 (-2.81)**	+0.47 LS3 (0.50)**	+0.45 LIN (4.13)**	+0.18 LU (2.97)**
	$R^2 = 0.88$					
LP13 =	-4.00 C (-5.87)**	-0.65 LO3 (-5.48)**	+0.26 LEP (1.80)*	-0.03 LPD (-1.49)*	$R^2 = 0.48$	
LEP =	0.24 C (-0.20)	-0.01 LO3L (-0.14)	-0.35 LP13 (-3.44)**	+0.96 LRI (6.28)**	+0.74 LPD (2.60)**	$R^2 = 0.98$
LS3 =	-1.87 C (-8.38)**	-0.18 LO3 (-3.43)	+0.06 LPU3G (1.26)	$R^2 = 0.43$		

MODEL THREE (C) LPUR

$$LO\ 3 = \begin{matrix} -9.31\ C & -0.30\ LP13 & -0.56\ LP33 & -0.81\ LS3 & +0.40\ LIN & +0.16\ LU \\ (-14.55)** & (-2.05)* & (-0.71) & (-0.36) & (3.00)** & (2.16)* \end{matrix}$$

$$R^2 = 0.88$$

$$LP13 = \begin{matrix} -3.94\ C & -0.64\ LO3 & +0.25\ LEP & -0.03\ LPD \\ (-5.78)** & (-5.38)** & (1.74)* & (-1.52)* \end{matrix}$$

$$R^2 = 0.48$$

$$LOP = \begin{matrix} -0.26\ C & -0.02\ LO3L & -0.37\ LP13 & +0.96\ LRI & +0.76\ LPD \\ (0.21) & (-0.23) & (-3.43)** & (6.20)** & (2.61)** \end{matrix}$$

$$R^2 = 0.98$$

$$LS3 = \begin{matrix} -2.15\ C & -0.24\ LO3 & -0.009\ LPUR \\ (-18.66)** & (-9.06)** & (-0.27) \end{matrix}$$

$$R^2 = 0.43$$

$$t_{0.01} = **$$

$$t_{0.05} = *$$

absolute income levels (+0.40 to +0.45) being greater than that of unemployment rates (+0.16 to +0.21), and neither have a significantly greater impact upon observed deterrent effects.

Finally, with the exception of sentence rates noted above, there are no major differences in co-efficient values across the crime rate function model structures estimated, suggesting as subsequent results (see below) confirm, that the introduction of the expenditure and severity functions provide little evidence of significant simultaneous effects upon initial model formulations.

5.4.5. Certainty Rate Functions

As Table Two indicates all co-efficient values are significant with crime rates negatively related to certainty (co-efficient values range from -0.59 to -0.64) expenditure positively related (+0.25 to +0.26) and population density negatively related (- 0.03 throughout). In contrast to aggregated results therefore the impact of changes in both offence levels and expenditure is proportionally lower (compared to aggregate estimates the change in Class III certainty rates for a given change in offence rates and expenditure is around 30% to 40% less) indicating that over the range of Class III crime rates analysed changes in both these variables appear to have less impact upon police efficiency. In addition, while for Class III crimes there is an apparent reduced likelihood of capture in more densely populated areas this result clearly conflicts with aggregated results and therefore the validity to be placed on this particular effect in the case of Class III crimes should be interpreted with caution. Finally, as in the case of Class III crime rate function co-efficients, values for the certainty function do not tend to vary across model structures.

5.4.6. Expenditure Rate Function

Similar to aggregated results, Class III expenditure function estimates are not consistent with theoretical prediction. Over the sample period the cost of supplying police resources (expenditure) does not appear to be related to the final output of these services (Class III offence levels). Moreover expenditure levels are negatively related to certainty (ranging from -0.34 to -0.37) suggesting that increases in the efficiency of the use of resources (via increases in certainty) are related to reduced expenditure. Finally neither of these results is consistent with other function values outlined above, namely expenditure being positively related to capture in the certainty function, and certainty being negatively related to offences in the crime rate function. There appears therefore no evidence to support theoretically predicted changes in expenditure, nor given these other results, the predominance of a recording effect.

Finally, both central variables are consistent and significant: rateable income and population density are positively related to expenditure, with values ranging from $+0.95$ to $+0.96$ and $+0.73$ to $+0.76$ respectively. Since both these ranges are similar to aggregated values (0.93 to 0.94 and 0.74 – see Table One) the income elasticity of demand for criminal justice services as well as the apparent diseconomies of scale in the production of these services does not appear to diverge across Class III crimes compared to property crimes as a whole.

5.4.7. Severity Function

As Table Two illustrates, while the level of offences is negatively and significantly related to sentences (-0.18 and -0.24 respectively for general and regional prison indexes) in neither case are prison utilization co-efficients significant. There is some evidence, as discussed above for the crime rate function; of a predominant 'negative severity effect' for Class III crimes i.e. endogenous increases in offence levels increasing the marginal costs of enforcement and therefore reducing the optimum level of sentences. Moreover, if this is the case, prison utilization indexes should also (for the same reason) be negatively related to sentences; this result is not apparent.

As discussed previously, disaggregation of crime classes allows analysis of any differences across class types for Scotland as a whole. On this basis it is clear that Class III estimates are relatively more consistent than those for Class II. However this very result prevents any broad conclusions being drawn. For example, in isolation, Class III results would suggest, on the basis of initial theoretical predictions concerning the ranking of deterrence evaluations, that the reallocation of a given level of C.J.S. resources away from court and prison services towards the police would, by increasing the probability of capture reduce social costs (as of course did previous aggregated results). However such a conclusion cannot be made in isolation, especially given that similar offence types (Class II crimes) exhibit little or no evidence of being subject to any of the theoretical effects postulated. Against the background of an economic model of the C.J.S. which should allow generalised conclusions to be drawn concerning both crime types it would thereby be inappropriate to base policy conclusions solely upon the more consistent Class III estimates.

Notwithstanding the above, and therefore before deriving any final conclusions, it is necessary to determine what the effect is upon initial model estimations of allowing for regional differences over both disaggregated and aggregated class types. Again such analysis might allow for, at least partial, explanation of the above differences.

5.4.8. Inter-Regional Results

The basis for estimation for both aggregated and disaggregated inter-regional functions is equivalent to that upon which the previous aggregated and disaggregated estimations were derived except that:

- The sample size is reduced to regional pairings; and
- an alternative dummy variable (DOC) is introduced to account for structural change.

As indicated from the previous analysis in Chapter Four there are apparent differences in the levels of socio-economic, criminal, and demographical variables across Scottish regions. To determine whether these differences alter initial results, procedures similar to those used for aggregate regional functions are adopted. Namely testing the hypothesis that pooled regional co-efficients, in this case for each given regional grouping, are the same. F-tests (using the F-statistic given at Table B1) were undertaken for all combinations of alternative groupings of two, three and four regions. Only in the case of specific two region groups was the hypothesis of pooled co-efficients not rejected, i.e. the hypothesis was rejected for some or all of the other grouping over all eight regions. These paired groups are: Northern and Dumfries; Grampian and Tayside; Lothian and Strathclyde; and Fife and Central.

Although the initial hypothesis of equality of all pooled co-efficients was not rejected for these pairings, in light of previous results the following (alternative) dummy variable was introduced into each function:

Structural Dummy (DOX). To account for a potential change in the level of endogenous variables over each regional pairing after 1975 a single dummy is introduced with a value of zero for the reference region over 1970–1974 and one over 1975–1978.

Not surprisingly (given the above) the hypothesis of equality of all paired regional co-efficients using this dummy was not rejected either. The resultant 'dummy combinations' across models one to three for both aggregated and disaggregated classes are given at Table B10.

Compared to previous estimations the results obtained from these model types, across both aggregated and disaggregated class types are relatively poor. To illustrate inter-regional results for the crime rate function are presented in summary format at Tables B11 to B12. As is apparent from these tables, in general it is only in the cases of Northern and Dumfries and Grampian and Tayside that any more than one co-efficient value is significant. Even in these cases there is little evidence of any deterrent effects – for example only aggregated results for both these regional groups indicate a significant deterrent effect for both certainty and the probability of conviction. Thus interregional function estimates provide little or no evidence consistent with theoretical expectations. While the degree to which these results reflect the relatively small sample size of regional pairings (18 for model one, and 16 for models two and three therefore reducing the degrees of freedom to within

a range of 4 to 12) as opposed to the lack of any deterrent effects on an individual regional basis remains unclear, the inferences which may be drawn concerning inter- regional as compared to aggregated effects are obviously severely limited.

5.5. Final Conclusions

In the light of the (above) lack of evidence of specific regional differences it is only possible to compare and comment upon aggregated and disaggregated results for the eight regions namely Scotland as a whole. Unfortunately as indicated in the introduction to this Chapter direct comparisons are not possible. Model structures differ; aggregated offence estimates include the proportion of violent offences as an explanatory variable, disaggregated models do not; aggregated offence functions include DRX as an instrumental variable Class II models do not; and finally Class II models also exclude estimation of any recording effect.

Of course, these differences may be indicative in themselves of potential variations in the motivation of offenders or practices used to deal with crimes over the classes analysed, and as such indirect comparisons (for example, differences in apparent positive and negative severity effects over Class II and III crimes respectively) are therefore constructive. Thus by function, broad trends, comparisons across models, and conclusions concerning results are reviewed below. Due emphasis is given to the broad set of model types analysed and therefore unreported results, since while they provide less evidence consistent with initial expectations, they do illustrate the context in which reported results were chosen and therefore the confidence which may be placed upon their validity.

5.5.1. Crime Rate Function

Three broad trends emerge across the classes:

- (i) Statistically significant and consistent results, obtained using Class III crimes, regional dummy explanatory variables and excluding a recording effect (as for example Table One results)
- (ii) Statistically significant but inconsistent results; obtained (in the majority of cases) using aggregated classes, regional dummies, and without inclusion of both recording effect variables. Inconsistency occurs in all cases because sentence rates are significant but positively related to offences; and
- (iii) statistically insignificant though consistent results; obtained over the majority of Class II models, and in the case of both aggregated and Class III models when a recording effect is present. Results are insignificant because either deterrent, or control variable co-efficients are not significant.

It is necessary to comment upon (ii) and (iii) as they contradict theoretical prediction, and therefore undermine the validity of (i). In the case of (ii) it is generally aggregate sentence rate co-efficients which are inconsistent; Class III rates tend to be negatively related to offence rates, and Class II rate co-efficients while generally positive also tend to be insignificant. Various explanations arise: sentence rates are incorrectly specified; aggregations bias;

and predominant positive severity effects. To assess the likelihood of the latter effect it is necessary to examine any evidence of the former effects through alternative specifications and inter-regional analysis.

Various lags were introduced into initial models, including static extrapolative, distributed and adaptive expectational structures. Over all deterrent variables (namely detection, certainty of punishment, and sentence length) resultant estimations were generally insignificant. Moreover where co-efficient values were significant, the directional value of lagged variables did not differ from initial estimations.⁴ So while it may be argued as in Chapter Four that present, as opposed to past punishment levels, are the appropriate reference index for potential offenders, over aggregate estimations a positive severity effect still predominates. Further, as already indicated above, inter-regional results provide no contradictory evidence to this conclusion.

In the case of (iii), it is clear that when introduced the recording effect reduces the significance of other variables. Since police per capita, and where introduced the proportion of violent offences, are both statistically significant for aggregation and Class III functions inclusion of a recording effect appears valid, but concurrently the role of recorded deterrence is reduced – changes in expected punishment may be a result not a cause of changes in recorded offence levels.

5.5.2. Certainty Rate Function

As in the case of the crime rate function, estimations differ according to crime class. For both aggregate and Class III crimes, co-efficient values are broadly consistent and statistically significant, while for Class II values results are

generally insignificant (excepting offence rates). While it is unclear from inter-regional analysis whether these differences are a result of varying regional practices or structural change, in light of crime rate function results, and also the different directional values of population density co-efficients across aggregate certainty function results (positive) compared to Class III results (negative) it may be concluded that variations across crime classes (i.e. motivation and general C.J.S. policies) provide an explanation. In short, Class II functions may be incorrectly specified.

5.5.3. Expenditure Rate Function

Two broad trends are apparent:

- (i) Over disaggregated classes, with regional explanatory dummies and excluding recording effects, control variables (population density and rateable income) are consistently and significantly related to expenditure BUT no other variables are significant; and
- (ii) In the case of all other model structures results are similar to (i) EXCEPT that the probability of capture is generally significant but negatively related to expenditure.

There is therefore no clear differentiation across classes: all results are relatively poor. Lagged offence rates do not appear to be a determinant of expenditure levels, and the probability of capture where significant is inconsistent. As stated previously, in contrast to crime rate function results, these estimations are unlikely to be due to a predominant recording effect. Thus given no apparent differences between regions expenditure levels appear

to be set without reference to either the efficiency of the resources used or the output derived from these resources.

5.5.4. SENTENCE RATE FUNCTION

Across all classes there is no evidence of a prison utilization capacity constraint upon sentence rates. So while the relation between sentences and offence rates coincides (not surprisingly) with crime rate results – limited evidence of a positive severity effect on aggregate; a negative severity effect for Class III crimes; and no relation in the case of class II results, initial predictions concerning the influence of prison utilization appear unfounded.

In light of the above it is concluded that although there appears to be limited evidence of deterrence (albeit not at optimum levels) in the case of the crime rate and certainty functions, the potential influence of recording practices and positive severity effects, the apparent differences across classes (and possibly regions) as well as the lack of supporting evidence over the expenditure and severity functions does (or should) not allow any firm policy conclusions to be drawn from the estimates outlined. Policy conclusions that is from the context of the theoretical predictions of the basic economic section has model outlined in Chapter One. It remains, as recommend in the next chapter, to determine whether policy conclusions may be drawn from alternative model specifications and therefore theoretical specifications.

CHAPTER 6

MAIN CONCLUSIONS

The purpose of Chapter Six is to provide a brief overview of the main conclusions of the study and recommendations for further work.

6.1. The main conclusions of this study are as follows:

1. Previous theoretical models of the Criminal Justice System have been constrained by the assumption that punishment is a price; predicting the efficient allocation of criminal justice resources does not necessarily depend on acceptance of this assumption (Chapter One);
2. Punishment is believed to fulfil other roles apart from deterrence; incorporation of these other roles into the economic model does not allow the determination of 'the optimum' allocation of Criminal Justice resources. (Chapter Two);
3. The economic theory of crime and punishment does not provide an adequate basis for empirical specification of the Criminal Justice System; economic specification of the Criminal Justice System; economic analysis of such systems is therefore limited to, at best, short term (marginal) policy recommendations (Chapter Three);
4. In addition, differences in class practices, local government

reorganisation, and apparent regional variations may all specifically affect the modelling and analysis of the Scottish Criminal Justice System over 1970 to 1978 (Chapter Four); and

5. The models estimated, and the results obtained, are inconclusive; no policy conclusions should be drawn about actual Scottish system practices.

6.2. Recommendations

Given the above conclusions, the following recommendations for future work in this area are suggested:

1. the (further) development of theoretical models which assume that punishment is not a deterrent. The testing and comparison of the resultant predictions against both economic models and actual practices to determine the relevance of the economic theory.
2. Given the above, the further review and analysis of the Scottish Criminal Justice to determine if the apparent inconclusive estimations obtained are a result of incorrect: theoretical foundations; transformations and/or specification.

NOTES

Chapter One – Notes

1. G.B. VOLD (1958); while this definition describes deterrence

in general, there are, however, numerous specific definitional categories, for example: "particularised deterrence": takes place when a sanction for a particular type of offence deters that particular type of offence only; 'generalised deterrence': takes place when a sanction for a particular type of offence deters a variety of offences, including the intended type of offence; 'selective deterrence': takes place when a sanction for a particular type of offence deters offences other than the intended type of offence". D BEYLEVELD (1978).

2. e.g.: "the crime of providing pornography has no easily discernible victim; certainly the purchasers do not generally see themselves in this way. If there are victims they are presumably the public at large and, the Festival of Light notwithstanding, the detriment to each individual member of the public is normally insufficient to stimulate much concern"; J.R. SHACKLETON (1978)

3. i.e.

$$\frac{\partial EU}{\partial p} = U_i(Y_i - f) - U_i(Y_i) < 0$$

(i)

$$\frac{\partial EU}{\partial r} = -p U_i(Y_i - f) < 0$$

(ii)

4. S.R. ZALBA; and: "crime (prohibited by criminal code) is the outward manifestation or sign of some disorder in the personality and character" J.R. REES both quoted in P. WARE (1979)
5. "It is the consistency with experience of the implied expectations from the maximizing rational behavioural postulate that is the test of the power of economics as a social scientific discipline when employed for the analysis of criminal activity by aggregates of individuals" S. ROTTENBERG (1973)
6. e.g. "So called 'short-cuts' to crime control may be regarded as a very unambitious approach to the problem. They only attempt to reduce the opportunities and temptations to crime instead of tackling its fundamental causes. But this is an economic study, and in the present state of knowledge, measures which alter opportunities and temptations possibly offer the simplest surest and least expensive methods of control"; R.L. CARTER (1974).V "The sentencing system may simply not be capable of compensating for the social ills of the wider society"; Presidents Commission (1967)
7. "Economic view concentrates on the perceived costs and benefits of the decision to commit an offence for the individual (and their probabilities) whereas criminology view takes these for granted and focuses attention on

socio-demographic factors determining the weights which the individual attaches to the consequences of his actions and the way their costs and benefits are perceived"

R.A. CARR-HILL & N. STERN (1979)

8. "Understanding is gained either by our finding an illuminating analogy to the phenomena whose character we do not understand, or by exposing a hidden mechanism the workings of which inevitably result in the phenomena that received explanation" R. HARRE in M. BLAUG (1980)

9. EHRlich postulates that:

$$X_a = W + W_i(+_i) + W_l(+ - +_i) - F_i(+_i)$$

(iiia)

$$X_b = W + W_i(+_i) + W_l(+ - +_i)$$

(iiib)

where:

$+$ = fixed time budget

W = Wealth not dependant on labour

W_i = Wealth from crime

W_l = Wealth from legal activity

F_i = Value of fine

; maximizing expected utility:

$$\frac{\partial EU}{\partial +_i} = p U'(X_a)(X_a)' + (1-p)U'(X_b)(X_b)' = 0 \quad (iv)$$

and given $W_i = W_i' (+i)$ etc, then

$$\frac{W_i - W_l}{W_l - W_i - f_i} = \frac{-pU'(X_a)}{(1-p)U'(X_b)} \quad (v)$$

and a sufficient condition for offending is therefore:

$$\frac{\partial EU}{\partial +_i} + i = 0 > 0 \quad (vi)$$

where:

$$\frac{W_i - W_l}{W_l - W_i - f_i} > \frac{-pU'(X_a)}{(1-p)U'(X_b)}$$

but given at $+_i = 0$, $X_a = X_b$, then (v) may be reformulated:

$$W_i - W_l > p f_i \quad (Va)$$

; i.e. crimes only take place if the marginal benefit from offending is greater than the expected cost of punishment.

10. i.e. assuming that p is positive and the utility of wealth is an increasing function of wealth so that $U'(X_a)$ and $U'(X_b)$

are also positive, then only increases in p unequivocally increase the value of:

$$\frac{p U'(X_a)}{(1-p) U'(X_b)}$$

(Vb)

and leave:

$$\frac{W_i - W_l}{W_i - W_c - f_i}$$

(Vc)

unchanged, so reducing the likelihood that (Va) holds for values of $+i > 0$. Increases in f_i , W_i and W_c all change the values of (Vb) and (Vc). For example given p , over all values of $+i$, an increase in f_i reduces X_a from X_a^0 to X_a^1 and leaves X_b unchanged. Depending on whether an offender is risk averse (i.e. $U'(X_a^1) > U'(X_a^0)$) or risk preferring (i.e. $U'(X_a^1) < U'(X_a^0)$) the value of (Vb) will rise or fall. For a risk averse offenders utility of wealth function $U(X)$ is concave, $U''(X) < 0$, for values x if:

$$\frac{U'(X_a^1)}{U'(X_b)} > \frac{U'(X_a^0)}{U'(X_b)}$$

(vii)

; whereas a risk preferring utility of wealth function is convex, $U''(X) > 0$, if:

$$\frac{U'(X_a^1)}{U'(X_b^1)} < \frac{U'(X_a^0)}{U'(X_b^0)}$$

(viii)

so since rises in f_i do not affect X_b , then $U'(X_a^0) > U'(X_a^1)$ is equivalent to (vii), and $U'(X_a^1) < U'(X_a^0)$ is equivalent to (viii). In both cases, given an increase in f_i , the value of (V_c) falls. Thus risk avoiders would therefore offend less, but it is uncertain in the case of risk preferrers what would occur (since the values of V_b and V_c both fall). For changes in W_i and W_j no predictions are possible. If W_i rises (falls) X_a and X_b increase (decrease). If W_j falls (rises) X_a and X_b decreases (increase). The changes in (V_b) are indeterminate. For example given a fall in W_i , for risk avoiders:

$$U'(X_a^1) > U'(X_a^0)$$

(ix)

but also:

$$U'(X_b^1) > U'(X_b^0)$$

(x)

so it is unclear if (vii) still holds. Changes in (vic) are still however clearcut. Assuming that (some) wealth is derived

from labour (legal and, or illegal) the value of (vic) falls (rises) respectively. But given the indeterminacy of (Vb) no overall directional changes arise.
 11. i.e. given

$$O_p < 0, O_f < 0$$

(5a)

dividing (8) by O_f yields:

$$D' + C' + b_p O \frac{1}{O_f} + b_{pf} = 0$$

(xia)

and dividing (9) by O_p :

$$D' + C' + C_p \frac{1}{O_p} + b_p O \frac{1}{O_p} + b_{pf} = 0$$

(xiiia)

, and given, by definition,:

$$\epsilon_f = \frac{f}{O} \cdot O_f$$

(xiiia)

and

$$\epsilon_p = \frac{p}{O} \cdot O_p$$

(xiiib)

then (8) and (9) may be reformulated as (8a) and (9a)

12. An alternative interpretation is the analogy between (8a) and (9a) and a monopolists maximum profit condition. For monopoly profits are maximised where:

$$MC = MR = p(1 + \frac{1}{\epsilon_p})$$

(xiv)

, for society losses are minimized where:

$$MC = MR = -p(1 - \frac{1}{\epsilon_p})$$

(xv)

the differences being that 'price' or 'average revenue' bpf is negative and split in two. Accordingly ϵ_f and ϵ_p are inelastic at the 'optimum' reversing the usual profit maximising condition of elastic demand.

13. i.e. recasting (8a) and (9a)

$$\epsilon_f = \frac{bpf}{D' + C' + bpf}$$

(xib)

$$\epsilon_p = \frac{bpf}{D' + C' + C_p \frac{1}{O_p} + bpf}$$

(xiib)

; and since all the terms of the expression for ϵ_f are positive

- see (2b) and (3) it follows that:

$$0 < \epsilon_f < 1$$

(xvi)

; and given that $C_p \frac{1}{O_p} < 0$ - see (2a) and (5a) - it follows that:

$$\epsilon_p < 1$$

(xvii)

; so given (8a) and (9a) and that:

$$D' + C' > D' + C' + C_p \frac{1}{O_p}$$

(xviii)

; then

$$-bpf \left(1 - \frac{1}{\epsilon_f}\right) > -bpf \left(1 - \frac{1}{\epsilon_p}\right)$$

(xix)

; and therefore a necessary condition for social cost minimization is that:

$$1 > \epsilon_p > \epsilon_f > 0$$

(10)

However this is a necessary, but not sufficient condition;

(10) may also be satisfied when:

$$\frac{\partial L}{\partial f} = \frac{\partial L}{\partial p} = 0$$

(xx)

14. i.e. from (6b) the percentage change in expected utility from an increase in p is:

$$-\frac{\partial EU}{\partial p} \cdot \frac{p}{U_i} = (U_i(Y_i) - U_i(Y_i - f)) \cdot \frac{p}{U_i}$$

(xxia)

; and from f is:

$$-\frac{\partial EU}{\partial f} \cdot \frac{f}{U_i} = (pU_i'(Y_i - f)) \cdot \frac{f}{U_i}$$

(xxib)

hence if:

$$-\frac{\partial EU}{\partial p} \cdot \frac{p}{U_i} > -\frac{\partial EU}{\partial f} \cdot \frac{f}{U_i}$$

(xxii)

then:

$$U_i(Y_i) - U_i(Y_i - f) \frac{p_i}{p} > p U_i'(Y_i - f) \frac{f}{U_i} \quad (\text{xxiia})$$

and therefore:

$$U_i(Y_i) - U_i(Y_i - f) > f U_i'(Y_i - f) \quad (11)$$

15. i.e. since $f U_i'(Y_i - f)$ measures the difference in utility between the gradient of $U_i(Y_i - f)$ at $U(Y_i)$, and $U(Y_i) - U_i(Y_i - f)$, for (11) to hold $U_i'(Y_i) > U_i'(Y_i - f)$ and hence $U_i'' > 0$.

16. Although not I. EHRlich. From (7) a percentage change in expected utility from an increase in p is:

$$\frac{\partial EU / \partial p}{EU} \cdot p_U = (w_i - w_l - f) - \lambda (w_i - w_l) \frac{p_U}{EU} \quad (\text{xxiii})$$

where:

$$\lambda = \frac{U'(xb)}{U'(xa)} \quad (\text{xxiv})$$

and from f is:

$$\frac{\partial EU / \partial t_i}{\partial f} \cdot f_{EU} = p \frac{f}{EU}$$

(xxv)

so if:

$$p (1 - \lambda) (w_i - w_1) - f > -pf$$

(xxvi)

then $\lambda > 1$, i.e. $U'(x_b) > U'(x_a)$ and therefore $U''(x) > 0$; all offenders are "risk preferers" at the optimum.

17. Unlike (11) where comparative differences in utility are measured at a given level of utility $U_i(Y_i)$, (11a) measures differences at $U_i(Y_p + G)$ – left hand side – and $U_i(Y_p)$ – right hand side. Consequently no direct comparisons between $U_i'(Y_p - f)$ and $U_i'(Y_p - G)$ are possible; for some values of G , $U_i'(Y_p - f) > U_i'(Y_p - G)$ whereas for other values, $U_i'(Y_p - f) < U_i'(Y_p - G)$ for the same utility of wealth function. Furthermore given decreasing absolute risk aversion as wealth increases, higher actual levels of present income and wealth imply that as G rises, offences will also rise. Hence the more likely that the inequality (11a) will be reversed at higher given levels of present income, wealth and potential gains.

18. i.e. where $b = 0$, the original optimal conditions (8,9) became:

$$L_f = O_f (D' + C') = 0$$

(xxic)

$$L_p = 0_p (D' + C') + C_p$$

(xxiic)

; since it is assumed that O_f is strictly negative for all $f > 0$, then $(D' + C')$ must equal zero for (xic) to hold. But if this is the case, for (xiic) to hold, p has to be reduced, and hence apprehension costs (since $C_p > 0$).

19. i.e. if:

$$R = f(f, O, \dots)$$

(xxvii)

where:

$$R_f, R_o > 0$$

then condition (8b) becomes:

$$L_f = O_f(D' + C_o + R_o) + R_f = 0$$

(xxviii)

given $R_f > 0$, then (xviii) holds only at some finite level of f .

20. This term covers: "those consequences which follow from

a sentence but are not formally part of it and are not specified in the sentence as pronounced". J.P. MARTIN & D. WEBSTER (1971). If statutory punishment (f_p) does not equal actual perceived punishment (f_a), given

$$\sum_{i=1}^n c_i x_i$$

represents all the (opportunity) costs consequent on conviction, including f_p then:

$$f_p = f(f_a) \text{ where } f_p = b_1 f_a$$

$$f_a = f(\sum_{i=1}^n c_i x_i) \text{ where } f_a = \sum_{i=1}^n c_i x_i$$

so

$$f_a = f_p + \sum_{i=2}^n c_i x_i$$

(xxix)

and

$$f_p = b_1(f_p + \sum_{i=2}^n c_i x_i)$$

(xxx)

so

$$f_p = \frac{1}{1 - b_1} (\sum_{i=2}^n c_i x_i)$$

(xxa)

and assuming $0 < b_1 < 1$ (i.e. f_p is some proportion of f_a)

then f_p is increased by $1/1-b_1$ - statutory punishment ALONE undermeasures the actual value of perceived punishment.

21. i.e. beyond the 'optimum' level of f , $L_f > 0$ i.e.

$$(D' + C') O_f + bp \frac{\partial (O, f)}{\partial f} > 0$$

(xxxii)

so given either

$$(D' + C') O_f < 0$$

(xxxiii)

for (xxi) to hold when $b < 0$ then:

$$\frac{\partial (O, f)}{\partial f} < 0$$

(xxxiii)

i.e. where $\epsilon_f > 1$, or alternative given $\epsilon_f < 1$ so (xxiii) is positive then for (xvii) to hold:

$$D'O_f > C'O_f + bp \frac{\partial (O, f)}{\partial f}$$

(xxxiv)

i.e. where $D' < 0$. Finally there may be no optimum - $\epsilon_f > 1$ or $D' < 0$ are not sufficient conditions for (xxi) to hold.

22. i.e. the maximum level of f that an apprehended offender

(a) will confess at being obtained by solving:

$$U_a(Y_p - f) = p_2 U_a(Y_p - f) + (1 - p_2) U_a(Y_p)$$

(xxxv)

for f .

23. e.g. if the complementary effect predominates:

$$[C]' = [C] \frac{\partial O_c}{\partial f_a} \cdot \frac{1}{O_{fa}} > [S] \frac{\partial O_s}{\partial f_a} \cdot \frac{1}{O_{fa}}$$

(xxxvi)

if

$$L_{f_{ao}}, L_{f_{al}} = 0$$

where

$$L_{f_{ao}} = D'_a + C'_a = -b_1 p_a f_{ao} (1 - \frac{1}{\epsilon_{fa}})$$

(xxxvii)

$$L_{f_{al}} = D'_a + C'_a + [C]' = -b_1 p_a f_{al} (1 - \frac{1}{\epsilon_{fa}})$$

(xxxviii)

given

$$D'_a + C'_a + [C]' > D'_a + C'_a$$

(xxxix)

at any given level of O_a

$$f_{al} > f_{ao}$$

(xxxx)

However since all offences CANNOT be complements for each other this effect will not predominate over all offence levels.

24. Given:

$$[A] = (D_a + C_a + b_1 p_a f_a)$$

(xxxxxi)

for f_c the complementary effect is

$$[A] \cdot \frac{\partial O_a}{\partial f_c} \cdot \frac{1}{O_{af}} > 0$$

(xxxixii)

and the substitution effect is

$$(S) \cdot \frac{\partial O}{\partial f_s} \cdot \frac{1}{O_{cf}} < 0$$

(xxxixiii)

But for substitute offences given no complements only substitute effects occur i.e.

$$[A] \frac{\partial O_a}{\partial f_s} \cdot \frac{1}{O_{fs}} + [C] \frac{\partial O_c}{\partial f_s} \cdot \frac{1}{O_{fs}} < 0$$

(xxxxiv)

and f_{sl} is always lower than f_{so} .

25. For example

$$\partial p_a / \partial p_s = 0$$

(xxxxv)

26. This assumed that the legal prohibition of "victimless crimes" is itself a welfare increasing policy; as noted previously some disagree with this view.

27. "Economic theory assumes the dominance of pure economic interests and precludes the operation of political or other non-economic interests". M. WEBER quoted in F. MALCHUP (1978).

Chapter Two – Notes

1. This assumes punishment is necessary. But if everyone shared the utilitarian goal of maximum social utility no crime would occur: everyone would benefit by the avoidance of the 'deadweight' social loss of crime. However economic theory presumes that individual utility maximization predominates. Maximizing social utility would have to be adopted as an ethical code: "if we put a sizeable O ['cost of conscience'] into the utility function of all individuals then violations of the laws will become rare"; G. TULLOCK (1971)
2. "There is no sense in talking about a 'just deterrent' or a 'just crime'. We demand of a crime not whether it is just but whether it succeeds. Thus when we cease to consider what the criminal deserves and consider only what will cure him or deter others, we have tacitly removed him from the sphere of justice altogether". C.S. LEWIS quoted in M.K. HARRIS (1974)
3. i.e. the reduction in future offences and therefore the reduction in future social costs that result.
4. J.E. HALL-WILLIAMS (1982) concluded that of recent surveys of the British prison population: "Estimates vary from 10 per cent of the population to as high as one quarter or one third of all prisoners either possessing a

mental history or showing signs of mental disorder or mental handicap". Furthermore as R.A. FERNANDEZ (1969) noted for heroin users involved in crime to sustain their needs the prospect of punishment ceases to be a deterrent: the use of heroin (or other opium derivatives) leads to metabolic dependence. Society would 'waste' resources in attempting to control 'heroin related crimes' via deterrence since they result from the actions of 'irrational' and hence undeterrable addicts.

5. i.e. "punishment does not serve or else serves quite secondarily in correcting the culpable or in intimidating possible followers. From this point of view its efficiency is justly doubtful and in any case mediocre. Its true function is to maintain social cohesion intact while maintaining all its vitality in the common conscience". E. DURKHIEM quoted in A.G. SALEM & W.J. BOWERS (1970)
6. "To the extent that a criminal sanction for a particular individual is extended or otherwise made more harsh for the purpose of deterrence, justice is no longer being done to the individual". M.K. HARRIS (1974)
7. Y.D. LOHMAN (1967); also: "if deviant behaviour is adaptive in some socio-economic circumstances, according to the logic implied in the discussion, then we may modify these contexts, and thereby make the deviance maladaptive". I. BERG (1969)

8. "To a certain extent of course correctional measures – by arresting criminals – do diminish the total amount of criminal behaviour, but this by far is not the only factor. Correctional intervention into the life of the offender is only a remedial measure. Some factors are responsible for the criminal behaviour in the first place. Increases and decreases in criminality in a given society are thus to a large extent independent of the quality of correctional measures". P.P. LEJINS (1978)

9. Retribution is likely to be a constraint rather than a single goal of any C.J.S.'s policy since: "When the problem is to find the best system of penalty fixing there is no doubt that a purely retributive theory would have serious weaknesses both practically, because it may be very difficult to decide which crimes are the more serious and thus deserving of severer punishment and morally because if deterrent and reformatory considerations are altogether ignored when the list of penalties is drawn up a great social good might be sacrificed to achieve a small improvement in the accuracy of a punishment from the retributive standpoint" K.G. ARMSTRONG (1961)

10. The following theoretical model is based on J.R. HARRIS' article: "On the Economics of Law and Order" (Journal of Political Economy, 1970) and G. TULLOCK'S book: "The Logic of the Law" (1971)

11. This assumes that $-bpf \frac{1}{\epsilon_f}$ and $-bpf 1 - \frac{1}{\epsilon_p}$ remain the same in both cases

12. The degree to which all offenders 'should' be protected is given by $\frac{\partial L}{\partial \alpha} = 0$. Thus either:

$$C_{\alpha} = -Rp_r \frac{\partial pr}{\partial \alpha};$$

(xxxxvi)

the marginal cost of increasing α should equal the marginal benefit derived. Or, if $O_{\alpha} > 0$ (if an increase in α reduces the likelihood of the guilty being punished and hence reduces the expected punishment for the guilty), then

$$(D' + C' + R' + bpf) O_{\alpha} = - (C_{\alpha} + Rp_r \frac{\partial pr}{\partial \alpha});$$

(xxxxvii)

the marginal cost of increasing α , as reflected by the increase in costs from increased offences, should be equated with the marginal benefits, as reflected by the excess of

$$-Rp_r \frac{\partial pr}{\partial \alpha} \text{ over } -C_{\alpha}.$$

13. These conditions are derived from:

$$\text{Min } L(D, C, f, p) \quad s\lambda \quad f < f_{\max} \quad f > 0.$$

(xxxxviii)

14. i.e. if

$$D'_{1+2} + C'_{1+2} > D'_{1+2} + C'_{1+2} + C_{p1} \frac{1}{O_{p1}} + C_{p2} \frac{1}{O_{p2}}$$

then at the optimum

$$-bp_1 f_1 \cdot 1 - \frac{1}{\epsilon_{f1}} = -bp_2 f_2 \cdot 1 - \frac{1}{\epsilon_{f2}} = -bp_1 f_1 \cdot 1 - \frac{1}{\epsilon_{p2}}$$

(xxxxix)

then:

$$\frac{p_1}{p_2} = \frac{f_2}{f_1} = \frac{(1 - 1/\epsilon_{f2})}{(1 - 1/\epsilon_{f1})} > \frac{p_2 f_2}{p_1 f_1} \cdot \frac{(1 - 1/\epsilon_{p2})}{(1 - 1/\epsilon_{p1})} = 1$$

(L)

therefore $p_1 > p_2$, which implies $f_1 > f_2$.

15. The following theoretical model is adapted from
K.L. AVIOS's article: "Recidivism in the Economic Model of
Crime". (Economic Inquiry, 1975)

Chapter Three – Notes

1. There are various alternative identification restrictions which, contingent on such data being made available, could be used – police deployment strategies not known to the public; (apprehension probability); judicial rules relating to evidence and time delays (conviction probability); and release programs and sentence rules (sentence length)

2. However, as stated in chapter one if the time allocated to legal and illegal activity is introduced explicitly into the utility function then: “no comparative static results are forthcoming under traditional preference restrictions. This is true because increasing the relative return to an activity will cause a wealth as well as a substitution effect” A.D. WITTE, (1980); i.e. it is necessary to assume the ‘normality’ (or wealth independence) of illegal activity.

3. For example in empirical models based on economic theory alone, the % of non-whites in the population is often used as a measureable proxy of ‘opportunity cost’. Non-whites tend to be discriminated against in the legal labour market and therefore have low wages and high unemployment rates relative to the rest of the population. This would indicate that they have a low opportunity cost of crime. However, other theoretical models predict that the % of non-whites is a proxy not of ‘opportunity cost’ but of ‘tastes’ or ‘attitudes’. For example ‘conflict theory’: “the

greater heterogeneity in a society be it cultural, ethnic, racial or religious can weaken the overall commitment to conformity through the existence of competing normative systems which may be at odds with the official institutionalized standards. As the members of society respond to behavioural codes of different subcultures there will be a larger variance in actual behaviour and more chance of deviance". A. BLUMSTEIN, J. COHEN & D. NAGIN,(1977). Or, alternatively, 'labelling theory': "the tendency to favour white over black, educated over uneducated, comes as little surprise to those who contend: ... that the least powerful among us are the most likely to be 'criminalized', inasmuch as the least powerful are also more likely to be observed, arrested and prosecuted". T.G. CHIRICOS, P.D. JACKSON & G.P. WALDO, (1972). Thus should the % of non -whites be regarded as an 'opportunity cost' or 'taste' variable? And should any negative association between this variable and the offence rate be interpreted as a result of differences in 'opportunity costs' or 'tastes' or both?

4. The following control measures come from a review of empirical models used by: K.L. AVIO (1979); P.W. BEATON (1974); T. BORGSTROM & R.P. GOODMAN (1973); T. BORCHERDING & R.T. DEACON (1972); W.J. BOWERS & G.L. PIERCE (1975); R.A. CARR-HILL & N. STERN (1979); J.I. CHAPMAN, W.Z. HIRSH & S. SONENBLUM (1975);

T.G. CHIORICOS, P.D. JAKSON & G.P. WALDO (1972); C.T. CLOTFELTOR (1977); L.E. COHEN (1981); S. DANZIGER & D. WHEELER (1975); I. EHRLICH (1973); B.E. FORST (1976); E.T. FUJII & J. MAK (1980); M.J. GREENWOOD & W.J. WADYCKI (1973); B.J. HILTON (1981); D. KENNETT (1979); L.R. McPHETER & W.B. STRONGE (1974); R. MANSFIELD, J.L. NANENWIRTH & L.C. GOULD (1974); V.K. MATHUR (1978); D. NAGIN (1981); T. ORSAGH (1973), (1981); J. PALMER & P. CARLESON (1976); P. PASSEL & J.B. TAYLOR (1977); L. PHILIPS & W.L. VOTEY (1981); T.F. POGUE (1975); D.O. POPP & F.D. SEBOLD (1972); D.J. PYLE (1982); D.L. SJOQUIST (1973); E. SWIMMER (1974); C.R. TITTLE & A.R. ROWE (1974); N. WALZER (1972); K.I. WOLPIN (1978); and J.A. YUNKER (1976)

5. i.e. from (xix):

$$\frac{fp + \sum_{i=2}^n c_i x_i}{0} \cdot \frac{\partial O}{\partial fp} > \frac{[fp]}{0} \cdot \frac{\partial O}{\partial fp}$$

(Li)

6. 'micro' refers to studies using unpublished data for specific offenders within a given region and time period e.g. R. THALER (1977): property crime Rochester, New York 1972 and A.D. WITHE (1980): past release activities of a random sample of 641 male ex prisoners North Carolina 1969-1971.

7. For example D. NAGIN (1978):

given

C_a = actual crime rate

C_p = potential crime rate

λ = expected number of crimes committed in period +

p = probability of apprehension and imprisonment per crime

s = sentence length

and

$C_p = f(C_a)$

(Lii)

where

$C_p = C_a + \lambda p s C_a$

(Liia)

then

$C_a = \frac{1}{1 - \lambda p s} C_p$

(Liib)

so

$\frac{\partial C_a}{\partial p} = \frac{-\lambda s}{1 - \lambda p s}^2 C_p$

(Liii)

$$\frac{\partial C_a}{\partial s} = \cdot C_p$$

(Liv)

therefore

$$\epsilon_p = \frac{-\lambda_p}{(1 + \lambda_{ps})^2} \cdot C_p \frac{(p)}{C_a}$$

(Liva)

$$\epsilon_f = \frac{-\lambda_p}{(1 + \lambda_{ps})^2} \cdot \frac{[C_p]}{C_a}$$

(Livb)

so given (Liib):

$$\epsilon_p = \epsilon_f = \frac{-\lambda_{ps}}{(1 + \lambda_{ps})}$$

(Lv)

; by comparing estimates of ϵ_p and ϵ_f from (Lv) with original values of ϵ^*p and ϵ^*f the 'isolated deterrent' effects are:

$$1 - \frac{\epsilon_p}{\epsilon^*p} \text{ and } 1 - \frac{\epsilon_f}{\epsilon^*f}$$

(Lvi)

since ϵ^*p and ϵ^*f measure deterrence and incapacitation their residuals (Lvi) measure deterrence.

8. For example the specific case of 'football hooliganism': "As the scale of control increases, that is, as magistrates become more ready to sentence offenders and police become more willing to act (knowing they will obtain convictions) then by definition there develops an 'objective' demonstration of the scale of the problem. That is, more and more soccer hooligans appear in the criminal statistics and the need for further control is emphasized"; I. TAYLOR (1972)

9. On the grounds that (1): "it is possible for an increased size of police force to produce more recorded crimes"; R.A. CARR-HILL & N.H. STERN (1977) and (2): "the number and behaviour and conspicuousness of the forces of social control do play a role in determining the perceived probability of apprehension which is in addition to any effect through the actual probability"; R.A. CARR-HILL & N.H. STERN (1979), where the perceived probability is a determinant of the number of crimes reported by victims

10. This assumes:

$$O_a = f(p(c), \dots$$

(Lvii)

$$O_r = f(p(c), c \dots$$

(Lviii)

where

$$\frac{\partial O_a}{\partial c} = \frac{\partial O_a}{\partial p} \cdot \frac{\partial p}{\partial c} <$$

(Lviia)

$$\frac{\partial O_r}{\partial c} = \frac{\partial O_r}{\partial p} \cdot \frac{\partial p}{\partial c} + \frac{\partial O_r}{\partial c} \quad \text{INDETERMINATE}$$

(Lviib)

given these relationships and

$$O_s < x \cdot O_a = O_r$$

(Lviia)

whereas at

$$O_a > x \cdot O_a = O_r$$

(Lviib)

So (57b) holds where:

$$\frac{\partial O_r}{\partial O_a} < 0$$

(Lix)

and (58a) holds where

$$\frac{\partial O_r}{\partial O_a} = 0$$

(Lix)

and (59) holds where:

$$1 > \frac{\partial \theta_r}{\partial \theta_a} > 0$$

(Lx)

and in all cases (58a) holds where

$$\frac{\partial \theta_r}{\partial \theta_a} = 1$$

(Lxi)

11. Evidence of recording effects is provided by various studies, for example: R. THALER (1977) reported a positive and significant relationship between police density and recorded crimes; and E.T. FUJII & J. MAK (1980) recorded a positive and significant relationship between police per capita and reported offences
12. i.e. as F.M. FISCHER & D. NAGIN (1978) note increased clearance rates which appear to reduce offence rates may be due to increases in such practices as reduced recording and increased plea bargaining (which given the implications derived in chapter one leads to lower sentences)
13. I. EHRLICH & J.C. GIBBENS (1977) argue that a priori there should be no such indirect effects if increases in certainty are 'warrented'. An inverse relationship between certainty and severity will only be caused by an: "increase in the

perceived social cost of punishment" or "unwarrented external interference". However if there is a trade-off between certainty and severity deterrent policies may be counterproductive. As D.C. BALDUS & J.W.L. COLE (1975) note, in I. EHRLICH'S (1973) empirical murder supply model if a 'percent increase in execution risk produces more than a .175 per cent fall in the conviction rate there is a net increase in homicide

14. Furthermore given sufficient data incorporation of this relationship not only helps to isolate the deterrent effect but also provides a basis for policy conclusions regarding the role of prison capacity in determining sentence length. Couple this with estimates of the relevant deterrent effects of different prison systems and the foundation is provided for the efficient allocation of resources within the penal system

Chapter Four – notes

1. Who has to decide: "whether an offence has been committed in law. If there is a sufficient evidence in law to prove it. The police do a good job but they are not lawyers, and you have got to know the legal requirements" quote from a procurator fiscal in S.R. MOODY & J. TOMBS (1982)
2. Since the sample period, 1970-78, includes the reorganisation of police authorities on the 16th May from twenty old into eight new regions, all data prior to 1975 (unless stated otherwise) is aggregated as shown in the table below.

OLD POLICE AUTHORITIES 1970-1974 AND EQUIVALENT
NEW POLICE AUTHORITIES 1975-1978

1970-74	1975-78
STIRLING AND CLACKMANNAN	CENTRAL
DUMFRIES AND GALLOWAY	DUMFRIES AND GALLOWAY
FIFE	FIFE
CITY OF ABERDEEN, SCOTTISH NORTH EASTERN COUNTIES	GRAMPIAN
BERWICK ROXBURGH AND SELKIRK, CITY OF EDINBURGH, AND LoTHIAN AND PEEBLES	LoTHIAN AND BORDERS
INVERNESS, NORTHERN, ROSS AND CROMERTY	NORTHERN
ARGYLL, AYRSHIRE, CITY OF GLASGOW, DUMBARTON, LANARK, RENFREW AND BUTE	STRATHCLYDE
ANGUS, CITY OF DUNDEE, PERTH AND KINROSS	TAYSIDE

SOURCE: SCOTTISH ABSTRACT OF STATISTICS NUMBER SIX (1976)

3. However if it is assumed that clear-up rates remained constant over 1974-75 the difference between the rate of change of recorded crimes and crimes cleared up would indicate the percentage increase in recorded crimes 'due' to the introduction of unsolvable cases in 1975. Hence 'the' increases in unsolvable cases for O2, O3, and O23 respectively would be: Dumfries and Galloway - 8%, 22%; 19%; Fife 0%, 3%, 2%; Northern -; 8%, 3%; Strathclyde 36%, 16%, 25%; and Tayside 10%, 11%, 10%.
4. Alternative proxies for 'potential gains' include estate duty returns and rateable property values. However in the former case the regional division is assessed according to where the estate is dealt with, which depends upon the domicile of the deceased and not upon where the property is situated. While in the latter case, rateable values are not necessarily in direct relation to the 'value' of the goods which may be potentially stolen (an extreme example being non-nuclear power stations).
5. For example, according to the Scottish Office data the 1970 Grampian June unemployment rate was 3.0 per cent. According to the Department of Employment Gazette the June rate for Aberdeen (excluding the temporarily unemployed) was 2.4 per cent, and the annual average rate

2.89 per cent. The percentage difference between the Aberdeen June and annual average is 20.42 per cent so the Grampian June rate was adjusted upwards by 3×1.2041 to 3.61

6. For example:

NET TOTAL INCOME FIFE =

[N.T.I.P.A: Edinburgh Borders and Tayside x E: Fife]
E: Fife, Lothian Borders and Tayside

N.T.I.P.A. = Net Total Income per Planning Area

E. = Total Employed per Police Authority
 (Department of Employment Gazette,
 Employees in Employment plus
 unemployed for local areas adjusted
 downwards by annual average
 unemployment rate)

7. In Central the average annual level declined by 5% from £522.82 to £497.28

8. However over 1976-78 Fife's relative position changed: by 1978 Fife's average income level was the lowest in Scotland

9. The above average rise in Dumfries resulted from an increase in police employed set against a population decline whereas in Fife police employment levels remained stable but population levels increased

10. For Tayside Ov declined throughout 1970-75

11. While such incorporations are rejected within the context of the study they are not rejected as a basis for future research – see Chapter Six

Chapter Five – Notes

1. A priori this assumes equality of all regression co-efficients over 1970–74. Unfortunately lack of degrees of freedom, given the sample size per region of five, prevents the direct testing of the equality of co-efficients over this period
2. For example in comparison to Model A results, the following estimations were obtained for comparable model structures including recording effects:

Model One (B)

$$LO23 = 0.16C + 0.07 LPI - 0.43 LP3 + 0.71 LS + LPPC$$

$$(0.1) \quad (0.62) \quad (-5.22)^{**} \quad (+429)^{**} \quad (+5.8)^{**}$$

$$+ 0.25 LOVS + 0.30 LIN + 0.33 LU$$

$$(2.09)^* \quad (3.13)^{**} \quad (6.75)^{**}$$

$$R^2 = 0.95$$

Model Two (B)

$$LO23 = -1.80C - 0.11 - 0.52 LP3 + 0.54LS + 0.77 LPPC$$

$$(-0.97) \quad (-1.01) \quad (-5.31)^{**} \quad (+3.43)^{**} \quad (3.18)^{**}$$

$$+ 0.37 LOV + 0.32 LIN + 0.27 LU$$

$$(2.66)^{**} \quad (3.37)^{**} \quad (5.38)^{**}$$

$$R^2 = 0.95$$

Model Three (C) LPUG

$$LO23 = -1.41 - 0.12 LPI - 0.52 LP3 + 0.41 LS + 0.83 LPPC$$

$$(0.77) \quad (-1.09) \quad (-5.28)^{**} \quad (2.25)^{[*]} \quad (3.13)^{**}$$

$$+ 0.39 \text{ LOV} + 0.30 \text{ LIN} + 0.26 \text{ LU}$$

$$(2.76)^{**} \quad (2.98)^{**} \quad (5.20)^{**}$$

$$R^2 = 0.95$$

Model Three (C) LPUR

$$\text{LO23} = -2.88\text{C} \quad -0.14 \text{ LPI} \quad -0.51 \text{ LP3} \quad +0.72 \text{ LS} \quad +0.63 \text{ LPPC}$$

$$(-1.36) \quad (-1.24) \quad (-5.14)^{**} \quad (3.21)^{**} \quad (2.24)^*$$

$$R^2 = 0.94$$

As is apparent therefore while both police per capita (LPPC) and the proportion of violent offences (LOV) are both positively and significantly related to offence levels throughout (ranging from + 0.63 to 1.00 and + 0.25 to + 0.39 respectively) the probability of certainty is not significant and sentence rate estimates indicate a positive severity effect. On this basis therefore, as indicated in the final conclusions of Chapter Five, when introduced, recording effects appear to predominate over any assumed deterrent influence of probable punishment.

3. As is the case when including a recording effect; the following estimates were obtained for comparable model structures to these at Table 2 except with inclusion of a recording effect:

Model One (G)

$$\text{LO3} = +1.52\text{C} +0.28\text{LP13} -0.61\text{LP33} -0.20\text{LS3} +1.44\text{LPPC} +0.19\text{LIN}$$

+0.27LU

(0.68) (1.47) (-3.19)** (-0.44) (5.18)** (1.55)* (4.55)**

$$R^2 = 0.88$$

Model Two (F)

LO3 = -0.99C -0.009LP13 -0.67LP33 +1.09LPPC +0.24LIN +0.20LU

(-0.45) (-0.06) (-3.47)** (-0.27) (3.82)** (2.23)* (4.02)**

$$R^2 = 0.91$$

Model Three (F) LPUG

LO3 = +1.12C +0.25LP13 -1.09LP33 +1.03L53 +1.35LPPC +0.21LIN
+0.27LU

(0.38) (1.09) (-2.70)** (0.96) (3.61)* (3.86)**

$$R^2 = 0.85$$

Model Three (F) LPUR

LO3 = -0.91C +0.07LP13 -0.31LP33 -1.11L53 +1.12LPPC +0.20LIN
+0.18LU

(-0.39) (0.45) (-0.49) (0.63) (3.68)** (1.50)* (2.84)**

$$R^2 = 0.84$$

4. Accordingly these results are redundant and therefore to avoid undue repetition are not reported

APPENDIX A

TABLE 1A: MEAN ANNUAL RECORDED CRIMES CLASS II (O2) CLASS III (O3)

AND CLASS II AND CLASS III (O23) PER 1000 CAPITA PER
POLICE AREA 1970-1978

POLICE AUTHORITY	PER 1000 CAPITA			PERCENTAGE CHANGE 1970-78		
	O2	O3	O23	O2	O3	O23
CENTRAL	12	16	28	+36	+50	+44
DUMFRIES AND GALLOWAY	5	13	18	+120	+59	+74
FIFE	9	12	21	+10	+40	+27
GRAMPIAN	8	17	25	+29	+54	+45
LOTHIANS AND BORDERS	16	24	40	+69	+63	+66
NORTHERN	6	13	18	-16	+23	+8
STRATHCLYDE	24	19	43	+72	+63	+67
TAYSIDE	15	19	34	-6	+42	+19

SOURCES: HER MAJESTYS CHIEF INSPECTOR OF CONSTABULARY FOR SCOTLAND
ANNUAL REPORTS AND REGISTRAR GENERAL SCOTLAND ANNUAL REPORTS

**TABLE 2A: PERCENTAGE CHANGES IN OR: 1974-75 COMPARED
TO ANNUAL AVERAGE CHANGES 1970-74 AND 1975-78**

PUBLIC AUTHORITY	1970-74			1974-75			1975-78		
	O2	O3	O23	O2	O3	O23	O2	O3	O23
CENTRAL	+8	+6	+5	+5	+2	+3	+6	+7	+6
DUMFRIES & GALLOWAY	+11	0	+3	+24	+18	+25	+7	+11	+9
FIFE	+5	+7	+8	+11	0	+1	-3	+3	+1
GRAMPIAN	-1	+5	+3	+24	+12	+7	+3	+4	+7
LOTHIANS & BORDERS	+4	+4	+4	+13	+14	+13	+8	+9	+8
NORTHERN	-7	+3	0	+11	+15	+13	+3	0	0
STRATHCLYDE	+2	+2	+4	+42	+16	+30	+5	+7	+6
TAYSIDE	-4	+2	0	+15	+22	+17	+2	+3	+2

**TABLE 3A: MEAN ANNUAL CLEAR-UP RATE CLASS II (P12) CLASS III (P13)
AND CLASS II AND CLASS III (P123) CRIMES PER POLICE AREA 1970-1978**

POLICE AUTHORITY	CLEAR-UP RATE			PERCENTAGE CHANGE 1970-78		
	P12	P13	P123	P12	P13	P123
CENTRAL	0.33	0.45	0.42	-16	-7	-10
DUMFRIES AND GALLOWAY	0.42	0.50	0.50	-32	-18	-23
FIFE	0.43	0.55	0.49	-32	-4	-14
GRAMPIAN	0.29	0.44	0.40	-22	-4	-7
LOTHIANS & BORDERS	0.22	0.41	0.34	-34	-12	-18
NORTHERN	0.40	0.56	0.48	+7	+15	+16
STRATHCLYDE	0.21	0.40	0.30	-35	-23	-28
TAYSIDE	0.23	0.41	0.34	-20	-12	-7

SOURCE: HER MAJESTYS CHIEF INSPECTOR OF CONSTABULARY FOR
SCOTLAND ANNUAL REPORTS

**TABLE 4A: PERCENTAGE CHANGES IN RECORDED CRIMES, CRIMES
CLEARED-UP AND THE CLEAR-UP RATE 1974-75**

POLICE AUTHORITY	RECORDED CRIMES			CRIMES CLEARED UP			CLEAR-UP RATE		
	O2	O3	O23	O2	O3	O23	O2	O3	O23
CENTRAL	9	6	8	15	4	8	6	-2	0
DUMFRIES & GALLOWAY	24	25	25	16	3	6	-8	-18	-15
FIFE	2	0	1	2	-3	-1	0	-2	-2
GRAMPIAN	21	12	6	23	15	17	0	4	11
LOTHIANS & BORDERS	8	13	11	12	18	17	4	5	5
NORTHERN	18	17	17	36	9	14	15	-8	-3
STRATHCLYDE	45	20	32	9	4	7	-23	-14	-19
TAYSIDE	9	16	13	-1	5	3	-12	-9	-9

SOURCE: AS TABLE 4

TABLE 5A: CLASSIFIED DEFINITIONS CLASS II AND III CRIMES 1970-78
CLASS II CRIMES CRIMES AGAINST PROPERTY WITH VIOLENCE

PUBLISHED DATA		UNPUBLISHED DATA	
CRIME CODE	DEFINITION	SUB-CODE	DEFINITION
18	HOUSEBREAKING	18-1	Theft by housebreaking
		18-2	Theft by opening lock-fast places
		18-3	Housebreaking with intent to enter and steal
		18-4	Attempted house-breaking
2	19	ROBBERY AND ASSAULTS WITH INTENT TO ROB	
3	20	OTHER CRIMES AGAINST PROPERTY WITH VIOLENCE	
		20-1	Flying aircraft to danger of property
		20-2	blasting - reckless use of explosives
		20-3	Explosive Substances Act 1883

CLASS III CRIMES: CRIMES AGAINST PROPERTY WITHOUT VIOLENCE

4	21	THEFT	21-1	Theft other than motor vehicle
			21-2	Theft of motor vehicle
	22	RESET		
	23	BREACH OF TRUST AND EMBEZZLEMENT		
5	24	FASLEHOOD FRAUD AND WILFUL IMPOSITION	24-1	False statement to obtain pension and insurance benefit
			24-2	Other fraud
	25	BANKRUPTCY OFFENCES (FRAUD)		
6	26	POST OFFICE OFFENCES	26-1	By Officials
			26-2	Not by Officials
			27-1	Taking motor vehicle without concent
	27	OTHER CRIMES AGAINST PROPERTY WITHOUT VIOLENCE	27-2	Clandestine removal of property
			27-3	Prevention of Corruption Acts
			27-4	Stamp Act 1841
			27-5	Public Stores Act 1875

SOURCE: SCOTTISH HOME AND HEALTH DEPARTMENT: CRIMINAL STATISTICS
SCOTLAND 1977 (1978)

**TABLE 6A: MEAN ANNUAL CONVICTION AND SENTENCE FOR DETENTION RATES
CLASS II (P 22) CLASS III (P23) AND CLASS II AND III (P223) PER
POLICE AREA 1970-78.**

POLICE AUTHORITY	CONVICTION RATE			PERCENTAGE CHANGE 1970-78		
	P22	P23	P223	P22	P23	P223
CENTRAL	0.24	0.11	0.15	21	-2	-1
DUMFRIES & GALLOWAY	0.24	0.11	0.14	21	-8	-2
FIFE	0.24	0.12	0.16	24	-6	0
GRAMPIAN	0.25	0.12	0.15	26	-7	1
LOTHIANS & BORDERS	0.25	0.11	0.15	21	-4	0
NORTHERN	0.25	0.12	0.15	14	-9	-10
STRATHCLYDE	0.25	0.11	0.16	21	-2	4
TAYSIDE	0.24	0.11	0.15	21	-3	0

SOURCE: AS TABLE 4

TABLE 7A: MEAN ANNUAL AVERAGE SENTENCE LENGTHS CLASS II(S2) CLASS III (S3) AND CLASS II AND III CRIMES (S23) PER POLICE AREA 1970-78

POLICE AUTHORITY	MEAN SENTENCE LENGTH (YEARS)			PERCENTAGE CHANGE		
	S2	S3	S23	S2	S3	S23
CENTRAL	0.52	0.32	0.41	2	-6	-5
DUMFRIES & GALLOWAY	0.52	0.33	0.40	2	-6	-3
FIFE	0.48	0.34	0.41	12	-6	3
GRAMPIAN	0.54	0.34	0.42	19	-11	2
LOTHIANS & BORDERS	0.55	0.32	0.42	1	-9	-5
NORTHERN	0.58	0.33	0.44	-20	-11	-20
STRATHCLYDE	0.58	0.32	0.45	4	-10	-2
TAYSIDE	0.51	0.32	0.41	4	-9	-5

SOURCE: SCOTTISH HOME AND HEALTH DEPARTMENT: CRIMINAL STATISTICS SCOTLAND.

**TABLE 8A: PERCENTAGE CHANGES IN F: 1974-75 COMPARED TO AVERAGE
CHANGES 1970-74 AND 1975-78**

POLICE AUTHORITY	1970-74			1974-75			1975-78		
	S2	S3	S23	S2	S3	S23	S2	S3	S23
CENTRAL	2	0	-3	25	3	15	-20	-6	-15
DUMFRIES & GALLOWAY	2	-3	0	33	0	13	-23	-3	-14
FIFE	26	0	13	0	3	0	-9	-9	-9
GRAMPIAN	10	-3	2	23	0	12	-14	-9	-10
LOTHIANS & BORDERS	4	-3	0	22	0	12	-21	-6	-13
NORTHERN	36	-6	9	-15	6	-8	-31	-11	-20
STRATHCLYDE	16	-3	7	17	0	11	-24	-9	-18
TAYSIDE	12	0	2	0	0	0	-7	-9	-7

SOURCE: AS TABLE 7A

**TABLE 9A: LOCAL AREA 'REFERENCE GROUPS':
UNEMPLOYMENT RATES 1970-1972**

POLICE AUTHORITY	LOCAL AREA EMPLOYMENT OFFICE
CENTRAL	FALKIRK
	STIRLING
DUMFRIES AND GALLOWAY	DUMFRIES
FIFE	DUNFERMLINE
	KIRKCALDY
GRAMPIAN	ABERDEEN
LOTHIANS AND BORDERS	EDINBURGH
	BATHGATE
NORTHERN	HIGHLANDS AND ISLANDS
STRATHCLYDE	AYR, DUMBARTON
	GLASGOW, GREENOCK
	IRVINE, KILMARNOCK
	NORTH LANARK, PAISLEY
TAYSIDE	DUNDEE
	PERTH

SOURCE: SCOTTISH ABSTRACT OF STATISTICS

**TABLE 10A: AVERAGE ANNUAL UNEMPLOYMENT RATES PER
POLICE AREA: 1970-1978**

POLICE AUTHORITY	AVERAGE RATE	PER CENTAGE CHANGE		
		1970-74	1974-78	1970-1978
CENTRAL	5.07	0.5	4	4.5
DUMFRIES & GALLOWAY	5.71	-0.7	5	4.3
FIFE	5.96	-1	4	3
GRAMPIAN	3.50	-1	2	1
LOTHIANS & BORDERS	4.63	-0.1	3	2.9
NORTHERN	6.63	-3	4	1
STRATHCLYDE	7.14	0	5	5
TAYSIDE	5.68	-0.4	5	4.6

SOURCES: DEPARTMENT OF EMPLOYMENT GAZETTES, SCOTTISH ABSTRACT OF
STATISTICS 1976, AND THE SCOTTISH ECONOMIC BULLETIN 1978

TABLE 11A: NEW POLICE AUTHORITIES, EQUIVALENT OLD SCOTTISH COUNTIES AND PLANNING REGIONS 1970-1975

NEW POLICE AUTHORITY	EQUIVALENT OLD COUNTIES	PLANNING REGION	EQUIVALENT OLD COUNTIES	ADJUSTMENTS
CENTRAL	CLACKMANNAN STIRLING	FALKIRK/ STIRLING	CLACKMANNAN STIRLING	None
DUMFRIES & GALLOWAY	DUMFRIES KIRKCUDBRIGHT WIGTON	SOUTH WEST	AYRSHIRE, DUMFRIES KIRKCUDBRIGHT WIGTON	Adjusted to exclude Ayrshire
FIFE	FIFE	EDINBURGH + TAYSIDE	EDINBURGH, FIFE, LOTHIANS ANGUS, FIFE, PERTHSHIRE AND KINROSS, DUNDEE	Adjusted to exclude Edinburgh, Lothians Angus, Perthshire and Kinross, Dundee
GRAMPIAN	ABERDEEN, BANFF, KINCARDINE, MORAY, NAIRN	NORTH EAST	ABERDEEN, BANFF, KINCARDINE, MORAY, NAIRN	None
LOTHIAN AND BORDERS	BERWICK, EDINBURGH, LOTHIANS, PEEBLES ROXBURGH, SELKIRK	EDINBURGH + BORDERS	AS ABOVE BERWICK, PEEBLES, ROXBURGH, SELKIRK	Adjusted to exclude Fife
NORTHERN	CAITHNESS, INVERNESS, ORKNEY, ROSS, SUTHERLAND, ZETLAND	HIGHLANDS	ARGYLL, CAITHNESS, INVERNESS ORKNEY, ROSS, SUTHERLAND, ZETLAND	Adjusted to exclude Argyll

STRATHCLYDE	ARGYLL, AYR BUTE, DUNBARTON, GLASGOW LANARK, RENFREW	GLASGOW	AYR, BUTE, DUMBARTON, GLASGOW, LANARK, RENFREW	Adjusted to include Ayr (South West) and Argyll (Highlands)
TAYSIDE	ANGUS, DUNDEE, TAYSIDE PERTH, AND KINROSS	AS ABOVE		Adjusted to exclude Fife

SOURCE: SCOTTISH ABSTRACT OF STATISTICS

**TABLE 12A: AVERAGE ANNUAL NET REAL INCOME
PER CAPITA PER POLICE AREA 1970-1978**

POLICE AUTHORITY	AVERAGE ()	PER CENTAGE CHANGE		
		1970-74	1974-78	70-78
CENTRAL	511	16	6	22
DUMFRIES & GALLOWAY	466	-7	14	7
FIFE	472	13	-10	3
GRAMPIAN	466	11	4	15
LOTHIANS & BORDERS	522	4	6	10
NORTHERN	411	14	7	21
STRATHCLYDE	495	15	-0.5	14.5
TAYSIDE	512	2	9	11

SOURCES: SURVEY OF PERSONAL INCOMES, SCOTTISH ABSTRACT OF STATISTICS,
AND CENTRAL STATISTICAL OFFICE ANNUAL ABSTRACT OF STATISTICS

TABLE 16A: POLICE PER THOUSAND CAPITA PER POLICE AREA 1970-1978

POLICE AUTHORITY	AVERAGE 1970-74	PERCENT- AGE CHANGE	AVERAGE 1974-78	PERCENT- AGE CHANGE	AVERAGE 1970-78	PERCENT- AGE CHANGE
CENTRAL	1.69	7	1.75	-1	1.72	8
DUMFRIES & GALLOWAY	1.69	7	1.94	20	1.82	27
FIFE	1.88	2	1.83	-1	1.86	1
GRAMPIAN	1.68	9	1.84	7	1.77	16
LOTHIANS & BORDERS	2.22	11	2.49	9	2.36	20
NORTHERN	2.05	13	2.37	2	2.15	15
STRATHCLYDE	2.29	14	2.55	8	2.42	22
TAYSIDE	2.10	10	2.23	4	2.17	14

SOURCE: HER MAJESTY'S CHIEF INSPECTOR OF CONSTABULARY FOR
SCOTLANDS ANNUAL REPORTS

**TABLE 17A: THE PROPORTION OF CLASS II CRIMES RECORDED TO THE
TOTAL NUMBER OF CLASS II AND III CRIMES RECORDED
PER POLICE AREA**

	AVERAGE LEVEL OF OV 1970-1978	% CHANGE 1970-74	% CHANGE 1974-75	% CHANGE 1975-78
CENTRAL	0.42	-7	2	0
DUMFRIES & GALLOWAY	0.29	+28	0	-3
FIFE	0.44	-4	0	-9
GRAMPIAN	0.32	-17	7	0
LOTHIAN	0.40	+3	-2	0
NORTHERN	0.30	-28	0.4	8
STRATHCLYDE	0.54	-4	8	-2
TAYSIDE	0.34	-13	-5	-5

SOURCE: AS TABLE 16A

**TABLE 13A: ANNUAL PER CAPITA REAL POLICE EXPENDITURE
£ PER POLICE AREA 1970-78**

	AVERAGE LEVEL OF 1970-78	% CHANGE 1970-74	% CHANGE 1974-78
CENTRAL	5.64	22	5
DUMFRIES & GALLOWAY	5.63	20	25
FIFE	5.79	17	2
GRAMPIAN	5.85	26	13
LOTHIAN	7.68	32	8
NORTHERN	7.34	36	6
STRATHCLYDE	8.55	31	9
TAYSIDE	7.35	27	18

SOURCE: HER MAJESTY'S CHIEF INSPECTOR OF CONSTABULARY FOR
SCOTLANDS ANNUAL REPORTS

**TABLE 14A: AVERAGE ANNUAL POPULATION
PER ACRE PER POLICE AUTHORITY 1970-78**

POLICE AUTHORITY	AVERAGE 1970-78	PERCENTAGE CHANGE 1970-78
CENTRAL	0.40	+8
DUMFRIES & GALLOWAY	0.09	+1
FIFE	1.04	+5
GRAMPIAN	0.20	+11
LOTHIANS & BORDERS	0.54	-0.75
NORTHERN	0.03	+11
STRATHCLYDE	0.70	+5
TAYSIDE	0.20	+18

SOURCE: ANNUAL REPORT OF THE REGISTRAR GENERAL FOR SCOTLAND
PART II POPULATION AND VITAL STATISTICS

**TABLE 15A: TOTAL ANNUAL PER CAPITA REAL RATE INCOME
EXPENDITURE PER POLICE AREA 1970-1978**

	1970-1974 %	1974-78 %	ANNUAL AVERAGE ()
CENTRAL	+24	+2	100.0
DUMFRIES & GALLOWAY	+14.5	+1	88.5
FIFE	+24.5	-6	91
GRAMPIAN	+21	+4	94
LOTHIAN	+23	+10	94.5
NORTHERN	+20	+6	115
STRATHCLYDE	+33	+4.5	106.5
TAYSIDE	+28	0	94

SOURCES: RATING REVIEW: PART FOUR RATE SUPPORT GRANT (1969/70-1973/74); RATING REVIEW: PART TWO RATING SERVICES (1974-75); AND RATES AND RATEABLE VALUES (1975-76-1978/9) C.I.P.F.A.

**TABLE 17A: THE PROPORTION OF CLASS II CRIMES RECORDED TO THE
TOTAL NUMBER OF CLASS II AND III CRIMES RECORDED
PER POLICE AREA**

	AVERAGE LEVEL OF OV 1970-1978	% CHANGE 1970-74	% CHANGE 1974-75	% CHANGE 1975-78
CENTRAL	0.42	-7	2	0
DUMFRIES & GALLOWAY	0.29	+28	0	-3
FIFE	0.44	-4	0	-9
GRAMPIAN	0.32	-17	7	0
LOTHIAN	0.40	+3	-2	0
NORTHERN	0.30	-28	0.4	8
STRATHCLYDE	0.54	-4	8	-2
TAYSIDE	0.34	-13	-5	-5

SOURCE: AS TABLE 13A

**TABLE 18A: PRISONS, YOUNG OFFENDERS INSTITUTIONS,
BORSTALS, AND DETENTION CENTRES DESIGNATED TO HOLD
OFFENDERS SENTENCED TO SERIOUS AND LESS SERIOUS
OFFENCES RESPECTIVELY
1970-1978**

SERIOUS OFFENCES		LESS SERIOUS OFFENCES	
INSTITUTION		INSTITUTION	
PRISON	ABERDEEN	PRISON	LOW MOSS
	BARLINNIE		PENNINGHAM
	DUMFRIES		DUNGAVEL (1975-78)
	EDINBURGH		
	GREENOCK	YOUNG OFFENDERS INSTITUTIONS	BARLINNIE
	INVERNESS		CORTON VALE
	PERTH		EDINBURGH
	PETERHEAD		FRIARTON
	CORTON VALE (1975-1978)		GREENOCK
	GLENOCHIL (1976-1978)		
YOUNG OFFENDERS INSTITUTION	DUMFRIES	BORSTALS	CASTLE-HUNTLY
			CORTON VALE
			GREENOCK
BORSTAL	FRIARTON (1970)		NORANSIDE
		DETENTION CENTRE	GLENOCHIL

SOURCE: 'PRISONS IN SCOTLAND' ANNUAL REPORTS. SCOTTISH
HOME AND HEALTH DEPARTMENT.

**TABLE 19A: THE GENERAL PRISON UTILIZATION RATION FOR SERIOUS
AND LESS SERIOUS OFFENCES SCOTLAND 1970-1978**

	RATIO SERIOUS OFFENCES	RATIO LESS SERIOUS OFFENCES	RATIO ALL OFFENCES
AVERAGE LEVEL	0.78	1.059	0.89
PERCENTAGE CHANGE 1970-74	+38	-20	+4.5
PERCENTAGE CHANGE 1974-78	+8	-17	-7.5
PERCENTAGE CHANGE PRISON PLACES	+5	+32.5	+15

SOURCE: AS TABLE 18A.

**TABLE 20A: PRISONS, YOUNG OFFENDERS INSTITUTIONS,BORSTALS,
AND DETENTION CENTRES, DESIGNED TO HOLD OFFENDERS ON REMAND
AND OR SENTENCED TO SERIOUS AND LESS SERIOUS OFFENCES PER
POLICE AREA 1970-1978**

POLICE AREA	INSTITUTION	
CENTRAL	PRISON	PERTH
DUMFRIES	PRISON	DUMFRIES
	YOUNG OFFENDERS INSTITUTION	DUMFRIES
FIFE	PRISON	PERTH
	YOUNG OFFENDERS INSTITUTION	GLENOCHIL (1976-78)
GRAMPIAN	PRISON	ABERDEEN
		PETERHEAD
LOTHIAN	PRISON	EDINBURGH
	YOUNG OFFENDERS INSTITUTION	EDINBURGH
NORTHERN	PRISON	INVERNESS
STRATHCLYDE	PRISON	BARLINNIE
	YOUNG OFFENDERS INSTITUTION	BARLINNIE GREENOCK
TAYSIDE	PRISON	PERTH
	YOUNG OFFENDERS INSTITUTION	FRIARTON

SOURCE: AS TABLE 20A

**TABLE 21A: REGIONAL CAPACITY RATIO PER POLICE AREA
SCOTLAND 1970-78**

POLICE AREA	AVERAGE	PERCENTAGE CHANGE	PERCENTAGE CHANGE
	1970-78	1970-74	1974-78
CENTRAL	1.03	+5	-13
DUMFRIES & GALLOWAY	0.68	-41	+48
FIFE	1.04	+9	-13
GRAMPIAN	1.00	-22	+9
LOTHIANS & BORDERS	1.38	0	-34
NORTHERN	1.33	+15	-6.5
STRATHCLYDE	1.25	-19	-45
TAYSIDE	1.00	-9	+23

SOURCE: AS TABLE 18A.

APPENDIX B

TABLE B1: CO-VARIANCE ANALYSIS AGGREGATE FUNCTIONS
WITHOUT DUMMY VARIABLES

To test the equality of all the regression co-efficients the appropriate statistic is (see A.C. HARVEY 1981):

$$F = \frac{[(CT - \epsilon)/n (G - 1)]}{[\epsilon - (T - nG)]}$$

; which has an F distribution with (nG - n, T - nG) degrees of freedom, and:

CT = Residual sum of squares of pooled data with no dummies (O.L.S. estimates).

ϵ = Sum of the residual sum of squares for each region.

n = Number of regression parameters for function.

G = Number of regions.

T = Total number of observations.

The results obtained from initial analysis of the hypothesis of the equality of all regression to co-efficients are outlined below:

TABLE B1

Function	ϵ	CT	F	Fng-n	T-ng,0.01	Hypothesis
Crime rate without recording effects	0.1295	1.7389	7.09	2.481	Rejected	
Crime rate with recording effects	0.0319	1.0428	4.63	5.048	Not rejected	
Certainty function	0.3468	1.1936	3.48	2.28	Rejected	
Expenditure function	0.0458	0.5987	8.31	2.535	Rejected	
Severity function General prison utilisation	0.2453	0.3907	1.36	2.282	Not rejected	
Severity function Regional prison utilisation	0.2266	0.3918	1.67	2.282	Not rejected	

Note:

1. Crime Rate Function without recording effects excludes police personnel per capita per region and the proportion of violent to non- violent crimes recorded per region as explanatory variables.

TABLE B2

Function	ϵ	CTDR	F	$F_{ng-n, T_{ng}, 0.01}$	Hypothesis
Crime rate without recording effects	0.1295	0.4357	1.35	2.481	Not rejected
Crime rate with recording effect	0.0319	0.2858	1.16	5.048	Not rejected
Certainty function	0.3468	0.914	2.33	2.28	Rejected
Expenditure function	0.458	0.1407	1.43	2.535	Not rejected
Severity function general prison utilisation	0.2453	0.3177	0.68	2.282	Not rejected
Severity function regional prison utilisation	0.2266	0.3149	0.89	2.282	Not rejected
Function	ϵ	CTDR	F	$F_{ng-n, T_{ng}, 0.01}$	Hypothesis
Crime rate without recording effect	0.1295	1.1192	2.95	2.481	Rejected
Crime rate with recording effects	0.0319	0.5297	3.05	5.048	Not rejected
Certainty function	0.3468	0.8354	2.00	2.28	Not rejected
Expenditure function	0.0458	0.3011	3.84	2.535	Rejected
Severity function general prison utilisation	0.2453	0.3463	0.96	2.282	Not rejected
Severity function regional prison utilisation	0.2266	0.3349	1.28	2.282	Not rejected

MODEL THREE

TYPE	DUMMY VARIABLE PER FUNCTION				FUNCTION REGRESSED				
	CRIME RATE (LO)	CERTAINTY (LP1)	EXPENDITURE (LE)	SEVERITY (LS)	LO	LP1	LE	LS	
A	DR	DRX	DR	DR	✓	✓	✓	✓	
B	DR	DRX	DR	DRX					✓
	CRIME RATE (LO/LPPC)								
		LP1	LE	LS					
C	DR	DRX	DR	DR	✓	✓	✓	✓	
D	DR	DRX	DR	DRX					✓
E	DRX	DRX	DR	DR	✓				

NOTES: WHERE A FUNCTION IS NOT REGRESSED (SEE LAST COLUMN OF TABLE) CO-EFFICIENT VALUES WILL NECESSARILY BE EQUAL TO ANOTHER MODEL TYPE. FOR EXAMPLE, MODEL TWO B, CERTAINTY AND EXPENDITURE FUNCTIONS, IS EQUIVALENT TO MODEL TWO C. THE ENDOGENOUS AND EXOGENOUS VARIABLES INCLUDING THE SET OF DUMMIES DR AND DRX ARE EQUAL FOR BOTH FUNCTIONS.

TABLE B4: Co-Variance Analysis Class II
Functions without Dummy Variables

Function	ϵ	CTDR	F	Fng-n,T _{ng} ,0.0: Hypothesis	
Crime rate without recording effect	0.2687	5.5333	11.19	2.481	Rejected
Crime rate with recording effect	0.0779	5.4201	22.25	2.979	Rejected
Certainty function	0.6759	2.3892	3.62	2.28	Rejected
Expenditure function	0.0432	0.6037	8.89	2.535	Rejected
Severity function general prison utilisation	0.7086	1.1677	3.12	2.282	Rejected
Severity function regional prison utilisation	0.6454	1.3376	2.46	2.282	Rejected

Note

1. Crime rate function with recording effect includes only police per capita as an explanatory variable.

TABLE B5:Co-Variance Analysis Class II
Functions with Dummy Variables

Function Hypothesis	ϵ	CTDR		F	Fng-n,T _{ng} ,0.0:
Crime rate without recording effect	0.2687	0.9553	1.46	2.481	Not rejected
Crime rate with recording effect	0.0779	0.9169	3/49	2.979	Rejected
Certainty function	0.6759	1.454	1.64	2.28	Not rejected
Expenditure function	0.0432	0.1493	1.68	2.535	Not rejected
Severity function general prison utilisation	0.7086	0.8741	0.53	2.282	Not rejected
Severity function regional prison utilisation	0.6454	0.9537	1.096	2.282	Not rejected
Function Hypothesis	ϵ	CTDRX	F		FnG-n,T-ng,0.01
Crime rate without recording effect	0.2687	4.089	8.12	2.481	Rejected
Crime rate with recording effect	0.0779	3.777	15.41	2.979	Rejected
Certainty function	0.6759	1.9531	4.56	2.28	Rejected
Expenditure function	0.0432	0.3593	5.02	2.535	Rejected
Severity function general prison utilisation	0.7086	0.9343	1.07	2.282	Not rejected
Severity function regional prison utilisation	0.6454	0.8968	1.19	2.282	Not rejected

TABLE B6: DUMMY COMBINATIONS CLASS II
MODEL THREE FUNCTIONS

TYPE	DUMMY VARIABLE PER FUNCTION				FUNCTION REGRESSED			
	CRIME RATE (LO)	CERTAINTY (LP1)	EXPENDITURE (LE)	SEVERITY (LS)	LO	LP1	LE	LS
A	DR	DR	DR	DR	✓	✓	✓	✓
B	DR	DR	DR	DRX	✓	✓	✓	✓

TABLE B7: CLASS II ESTIMATES

MODEL ONE

$$\begin{aligned} \text{LO2} &= -7.62\text{C} - 0.42 \text{LP12} - 0.08 \text{LP32} + 0.27 \text{LS} + 0.24 \text{LIN} + 0.34\text{LU} \\ &\quad (-7.33)^{**} \quad (-0.97) \quad (-0.60) \quad (0.86) \quad (1.55) \quad (2.19)^* \\ &\quad R^2 = 0.93 \end{aligned}$$

$$\begin{aligned} \text{LP13} &= -7.41\text{C} - 0.75 \text{LO2} - 0.25 \text{LEP} + 0.55 \text{LpD} \\ &\quad (-0.89) \quad (-4.19)^{**} \quad (-1.04) \quad (0.84) \\ &\quad R^2 = 0.75 \end{aligned}$$

MODEL TWO

$$\begin{aligned} \text{LO2} &= -8.11\text{C} - 0.84\text{LP12} - 0.01\text{LP32} + 0.03\text{LS2} + 0.29 \text{LIN} + 0.19 \text{LV} \\ &\quad (-6.65)^{**} \quad (-2.26)^* \quad (-0.05) \quad (0.09) \quad (1.43)^* \quad (1.31)^* \\ &\quad R^2 = 88 \end{aligned}$$

$$\begin{aligned} \text{Lp13} &= -2.53\text{C} - 0.84 \text{LO2} - 0.16 \text{LEP} + 0.72 \text{LpD} \\ &\quad (-0.67) \quad (-4.26)^{**} \quad (-0.33) \quad (0.88) \\ &\quad R^2 = 0.70 \end{aligned}$$

$$\begin{aligned} \text{LEP} &= 0.23\text{C} + 0.02 \text{LO2L} - 0.16 \text{LP12} + 0.87 \text{LP} + 0.70 \text{LpD} \\ &\quad (0.19) \quad (0.3) \quad (-1.69) \quad (6.42)^{**} \quad (3.28)^{**} \\ &\quad R^2 = 0.90 \end{aligned}$$

MODEL THREE (A) LPUG¹

$$\begin{aligned} \text{LO2} &= -8.03\text{C} - 0.81 \text{LP12} + 0.03 \text{LP32} + 0.12\text{LS2} + 0.30 \text{LIN} + 0.23 \text{LU} \\ &\quad (-6.68)^{**} \quad (-2.30)^* \quad (0.11) \quad (0.32) \quad (1.48)^* \quad (1.49)^* \\ &\quad R^2 = 88 \end{aligned}$$

$$\begin{aligned} \text{Lp12} &= -2.22\text{C} - 0.76 \text{LP12} - 0.21 \text{LOP} + 0.66 \text{LpD} \\ &\quad (-0.61) \quad (-2.74)^{**} \quad (-0.47) \quad (0.83) \\ &\quad R^2 = 0.72 \end{aligned}$$

$$\begin{aligned} \text{Ltp} &= -0.92\text{C} - 0.13 \text{LO2L} - 0.41 \text{Lp12} + 0.83 \text{LR} + 0.61 \text{LpD} \\ &\quad (-0.45) \quad (-0.75) \quad (-1.53) \quad (4.44)^{**} \quad (1.99)^{**} \\ &\quad R^2 = 0.82 \end{aligned}$$

$$\begin{aligned} \text{LS2} &= -0.44\text{C} + 0.009 \text{LO2} + 0.78 \text{LpUG} \\ &\quad (-2.33)^* \quad (0.28) \quad (1.78) \\ &\quad R^2 = 0.01 \end{aligned}$$

Note

1. As model three (a) LpUR and model three (b) LpUG and LpUR estimates are similar to the above results they are not repeated.

TABLE B8: Co-Variance Analysis
Class III Functions with Dummy Variables

Function	ϵ	CTDR	F	Fng-niT_ngi0.0: Hypothesis	
Crime rate without recording effect	0.2171	0.5317	0.83	2.481	Not rejected
Crime rate with recording effect	0.0683	0.3543	1.36	2.979	Not rejected
Certainty function	0.3519	0.8919	2.19	2.28	Not rejected
Expenditure function	0.0401	0.1331	1.56	2.535	Not rejected
Severity function general prison utilisation	0.0629	0.066	0.74	2.282	Not rejected
Severity function regional prison utilisation	0.0832	0.0712	2.14	2.282	Not rejected

Function	ϵ	CTDRX	F	FnG niTn-gi0.01 Hypothesis	
Crime rate without recording effect	0.2171	1.0365	2.17	2.481	Not rejected
Crime rate with recording effect	0.0683	0.6984	2.90	2.979	Not rejected
Certainty function	0.3519	0.8298	2.13	2.28	Not rejected
Expenditure function	0.0401	0.3688	5.52	2.535	Rejected
Severity function general prison utilisation	0.0629	0.0742	0.41	2.282	Not rejected
Severity function regional prison utilisation	0.0832	0.0903	0.28	2.282	Not rejected

TABLE B 9 : DUMMY COMBINATIONS CLASS III
AGGREGATE FUNCTIONS

MODEL ONE

TYPE	DUMMY VARIABLE PER FUNCTION			FUNCTION REGRESSED	
	CRIME RATE (LO)	CERTAINTY (LPI)		LO	LPI
A (E)	DR	DR		✓	✓
B (F)	DRX	DR		✓	✓
C (G)	DR	DRX		✓	✓
D (H)	DRX	DRX		✓	✓

MODEL TWO

TYPE	DUMMY VARIABLE PER FUNCTION				FUNCTION REGRESSED		
	CRIME RATE (LO)	CERTAINTY (LPI)	EXPENDITURE (LE)		LO	LPI	LE
A (D)	DR	DR	DR		✓	✓	✓
B (E)	DRX	DR	DR		✓	✓	✓
C (F)	DR	DRX	DR		✓		✓

MODEL THREE

TYPE	DUMMY VARIABLE PER FUNCTION					FUNCTION REGRESSED			
	CRIME RATE (LO)	CERTAINTY (LPI)	EXPENDITURE (LE)	SEVERITY (LS)		LO	LPI	LE	LS
A (E)	DR	DR	DR	DR		✓	✓	✓	✓
B (F)	DR	DR	DR	DRX		✓	✓	✓	✓
C (G)	DR	DRX	DR	DR			✓		✓
D (H)	DRX	DR	DR	DR		✓			

Model types including the recording effect are given in parenthesis

TABLE B10: DUMMY COMBINATIONS
INTER-REGIONAL ANALYSIS

MODEL ONE

TYPE	DUMMY VARIABLE PER FUNCTION		FUNCTION REGRESSED	
	CRIME RATE (LO)	CERTAINTY (LP)	LO	LP
A	-	-	✓	✓
B	-	DOX	✓	✓
C	DOX	-	✓	✓
	CRIME RATE (LO/LPPC)	CERTAINTY (LP)		
D	-	-	✓	✓
E	-	DOX	✓	✓
F	DOX	-	✓	✓

TABLE B10: DUMMY COMBINATIONS
INTER-REGIONAL ANALYSIS

MODEL TWO

TYPE	DUMMY VARIABLE PER FUNCTION			FUNCTION REGRESSED		
	CRIME RATE (LO)	CERTAINTY (LP)	EXPENDITURE (LEP)	LO	LP	LEP
A	-	-	-	✓	✓	✓
B	-	DOX	-	✓	✓	✓
C	DOX	-	-	✓	✓	
D	-	-	DOX			✓
CRIME RATE (LO/LPPC) CERTAINTY (LP) EXPENDITURE (LEP)						
E	-	-	-	✓	✓	✓
F	-	DOX	-	✓	✓	✓
G	DOX	-	-	✓	✓	
H	-	-	DOX			✓

TABLE B11: DUMMY COMBINATION
INTER-REGIONAL ANALYSIS

MODEL THREE

TYPE	DUMMY VARIABLE PER FUNCTION				FUNCTION REGRESSED			
	CRIME RATE (LO)	CERTAINTY (LP)	EXPENDITURE (LEP)	SEVERITY (LS)	LO	LP	LEP	LS
A	-	-	-	-	✓	✓	✓	✓
B	-	DOX	-	-	✓	✓	✓	✓
C	DOX	-	-	-	✓	✓		
D	-	-	DOX	-			✓	
E	-	-	-	DOX				✓
	CRIME RATE (LO/LPPC)	CERTAINTY (LP)	EXPENDITURE (LEP)	SEVERITY (LS)	LO	LP	LEP	LS
F	-	-	-	-	✓	✓	✓	✓
G	-	DOX	-	-	✓	✓	✓	✓
H	DOX	-	-	-	✓	✓		
I	-	-	DOX	-			✓	
J	-	-	-	DOX				✓

TABLE B11: INTER-REGIONAL CRIME RATE FUNCTION
DISAGGREGATED CRIME CLASSES
SUMMARY OF MODEL ONE TO THREE
RESULTS

[illegible]¹ LIN significant

TABLE B12: INTER-REGIONAL CRIME RATE FUNCTION
AGGREGATE CRIMES SUMMARY OF MODEL ONE TO THREE
RESULTS

VARIABLES

LP1LP3LS	LP1LP3LS	LP1LP	LP1L3	LP1LS	LP1LP3	LP1LS	LP3LS	LP1	LP3	LS	LP1LP3	LP1LS	LP3LS	OTHERS
LIN LU	LIN	LIN LU	LIN LU	LIN LU	LIN/LU	LIN	LIN	LIN LU	LIN LU	LIN LU	LIN LU	LP1LS	LP3LS	
(LPPC)	(LPPC)	(LPPC)	(LPPC)	(LPPC)	(LPPC)	(LPPC)	(LPPC)	(LPPC)	(LPPC)	(LPPC)	(LPPC)	(LPPC)	(LPPC)	

INTER-REGION

NO/DU	A_2B_2	$A_1B_1^1$	A_1B_1	$(D_1)(E_1)$	ALL OTHER RESULTS
	$A_{3g}B_{3g}$				

GR/T	A_2B_2	$A_{3r}B_{3r}^2$			ALL OTHER RESULTS
	$A_{3g}B_{3g}$				

LB/SR					ALL RESULTS
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F/C			B_1		ALL OTHER RESULTS
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1 LIN significant
2 LU significant

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